AD-A068 833 GAI CONSULTANTS INC MONROEVILLE PA F/G 13/2
NATIONAL DAM INSPECTION PROGRAM. BEAVER RUN DAM, NDI NUMBER PA---ETC(U)
JUL 78 DACW31-78-C-0052
UNCLASSIFIED NL

END
DATE FILMED
6 -79
DDC

OHIO RIVER BASIN
BEAVER RUN, WESTMORELAND COUNTY

PENNSYLVANIA

BEAVER RUN DAM
NDI No. Pa. - 484

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

(6) Beaver Run Dam, NDI Number PA-484. Ohio River Basin, Beaver Run, Westmoreland County, Pennsylvania. Phase I Inspection Report.

Distribution Unlimited
Approved for Public Release
Contract No. DACW31-78-C-0052

(12) 90 p.

(15)

PREPARED FOR

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

PREPARED BY

GAI CONSULTANTS, INC.
570 BEATTY ROAD
MONROEVILLE, PENNSYLVANIA 15146

(11) JUL[redacted]78

DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DDC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

PHASE I REPORT
National Dam Inspection Program

Beaver Run Dam

Pennsylvania

Westmoreland

Beaver Run

11 May 1978 (visual inspection)

Inspection Team - GAI Consultants, Inc.
570 Beatty Road
Monroeville, Pennsylvania 15146

Based on a visual examination, as well as available engineering data, the dam is considered to be in good condition. Hydrologic and hydraulic calculations indicate that the facility can pass and/or store the flow resulting from the PMF. Additional calculations, however, indicated that if not properly vented, the morning glory spillway may pass through a period when a make and break siphoning action would attend flow. This action would be accompanied by surges at the inlet and outlet ends and by thumping and vibrations within the outlet. Since no design reports are available for the appurtenances, it is not known if this condition was considered during the design. Discussions with owners representatives and local residents also indicated that remedial repair to the outlet works was required at least once and possibly twice since construction. Consequently, it is recommended that a detailed hydraulic and hydrologic analysis be performed to accurately assess the present condition of the outlet and to make any modifications deemed necessary to insure that the outlet will perform adequately under all possible operating conditions.

In addition, the flow which is issuing from the right abutment-embankment contact should be collected and continuously monitored for evaluation. If the condition worsens, remedial measures should be implemented to stop the seepage.

Since there is only a limited internal drainage system in the embankment at the old stream channel, it is also recommended that the owner be required to install observation wells in the embankment to monitor and establish the phreatic surface. The results of this study should be evaluated by a registered professional engineer experienced in the design and construction of earthen dams.

A warning system should also be developed to allow for the safe evacuation of all downstream inhabitants should the need arise and the dam should be inspected on a periodic basis by qualified personnel to detect any hazardous conditions that may be developing.

GAI Consultants, Inc.

Bernard M. Mihalcin, P.E.

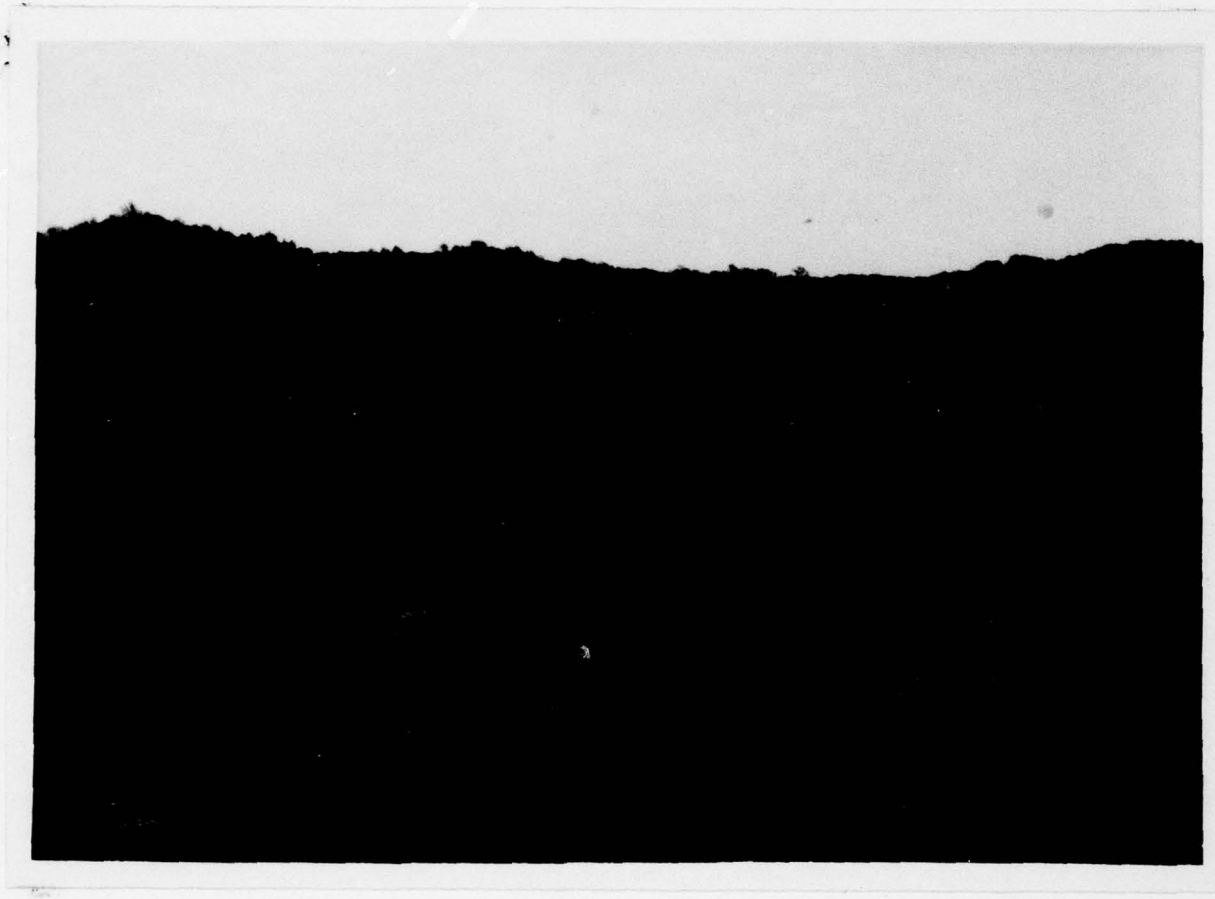
Date July 21, 1978

Approved:

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

Date 31 Jul 78

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL ENGINEER
BERNARD M. MIHALCIN
20371-E



Overview Photograph of Beaver Run Dam

TABLE OF CONTENTS

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
BEAVER RUN DAM
ID NDI# PA-484, PENNDER# 65-114

1.0 Authority.

The Dam Inspection Act, Public Law 92-367 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

1.1 Purpose.

The purpose is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Beaver Run Dam is an earthen embankment approximately 1,095 feet long and 91 feet high at the original streambed. According to available construction drawings, the facility is equipped with a 10-foot diameter concrete morning glory spillway as well as two 42-inch diameter cast iron supply pipes both of which pass beneath the dam near the center of the structure. There is also a low point in the left abutment which will serve as an emergency spillway. Access to a gate house containing control valves at the upstream end of the low-level conduits is provided by a foot bridge (see Photograph 4).

b. Location. The Beaver Run Dam is located along Route 380 between Perrysville and North Washington in Westmoreland County, Pennsylvania. The dam, reservoir, and watershed can be located on the following U.S.G.S. 7.5 minute quadrangles; Vandergrift, Murrysville, Saltsburg, Slickville, Greensburg, and New Kensington East. The coordinates of the dam are N40° 30' 50", W79° 33' 10".

c. Size Classification. Intermediate (91 feet high, 33,000 acre-feet).

d. Hazard Classification. High hazard.

e. Ownership. Municipal Authority of Westmoreland County.

f. Purpose of Dam. Water supply for both residential and industrial use.

g. Design and Construction History. The Beaver Run Dam is located along Route 380 between Perrysville and North Washington in Westmoreland County. The dam is an earthen embankment designed by Gannett, Fleming, Corddry, and Carpenter, Inc., of Harrisburg, Pennsylvania. Construction of the dam was completed in August 1952.

The original design called for an earth embankment with a downstream rock zone (see Figure 3). Preliminary investigations failed to produce the quantity of material needed to construct the rockfill portion of the embankment and subsequently an earthen embankment was reportedly constructed (see Geology, Appendix E). The details of embankment construction are only inferred since as-built drawings are not available.

The outlet works of Beaver Run Dam consists of a 10-foot diameter drop inlet "Morning Glory Spillway", an emergency spillway in natural materials on the left abutment, along with two 42-inch diameter cast iron supply pipes apparently gated at the channel bed (see Figures 3, 4, 5, and 6 and Photographs 2 and 4). The only post construction change of any signficance occurred in 1962 when the spillway crest elevation was increased from 1,045 feet to 1,050 feet.

There are no formal reports available which indicate any significant problems with the structure during its life span. The last reported inspection of the structure was conducted in April 1978 by Bankson Engineers. The only deficiency indicated by this report was an area of seepage, termed minimal, on the eastern edge of the downstream slope. The report concludes that the seepage did not pose any immediate problem.

h. Normal Operation Procedure. (see Section 4.1).

1.3 Pertinent Data.

a. Drainage Area - 43.2 square miles.

b. Discharge at Dam Site - Records not available.

Outlet Works Conduit at Operating Pool Elevation - Discharge curve not available.

Maximum Discharge of Primary Spillway (Morning Glory) at Elevation 1075 ≃ 3728 cfs.

Maximum Discharge of Emergency Spillway (Route 380) at Elevation 1075 ≃ 13,271 cfs.

Maximum Discharge of Blow-off Conduit (42 inch C.I.P) at Elevation 1075 ≈ 332 cfs.

c. Elevation (feet above mean sea level).

Top of Dam - 1075.

Maximum Pool Design Surcharge - Not known.

Maximum Pool of Record - 1053 (as per conversation with water company representative).

Normal Pool - 1050 (primary spillway crest).

Emergency Spillway Control ≈ 1070.

Upstream Portal Invert Outlet Conduit ≈ 985.

Downstream Portal Invert Outlet Conduit ≈ 983.

Streambed at Centerline of Dam ≈ 983.

Maximum Tailwater - 8 feet (see Appendix C).

d. Reservoir (miles).

Length of Maximum Pool ≈ 4.7 (elevation 1075 top of dam).

Length of Normal Pool ≈ 4.4 (elevation 1050 primary spillway crest).

e. Storage (acre-feet).

Primary Spillway Crest ≈ 34,000 (elevation 1050).

Design Surcharge - Not known.

Top of Dam ≈ 74,000 (elevation 1075).

f. Reservoir Surface (acres).

Top of Dam ≈ 1800.

Primary Spillway Crest ≈ 1250.

g. Dam.

Type - earth.

Length - 1095 feet.

Top Width - 22 feet.

Side Slopes - upper downstream 2H:1V
lower downstream 2-1/2H:1V
upper upstream 3H:1V
middle upstream 2-1/2H:1V
lower upstream 3H:1V

Zoning - (inferred from drawings and PennDER files) - Rolled earth with a riprap bedding on upstream face. According to the most recent pre-construction drawings, a 40-foot wide sand and gravel filter was installed in the old streambed (see Figure 3).

Impervious Core - Earthfill (details unknown).

Cutoff - Design drawings indicate a cutoff trench, 30 feet wide at the base, was excavated to rock and backfilled with embankment materials. In addition, a concrete cutoff wall apparently extends 5 feet above and below the top of rock from abutment to abutment.

Grout Curtain - None.

h. Outlet Conduit.

Type - Two 42-inch diameter cast iron supply pipes with sluice gates at entrance. Both conduits originate at the base of the intake tower where they can draw water from three different elevations. One of the pipes reportedly carries water to an adjacent filtering plant while the other reportedly supplies Allegheny Ludlum Steel Corporation. A 12-inch diameter blow-off is reportedly connected to the industrial supply line at a point approximately 100 feet downstream.

Closure - Valve at intake.

Access - Foot bridge to intake tower.

Regulating Facilities - 3 gate valves at elevations 985, 1005, and 1025, respectively.

i. Spillway.

Type - (primary) drop inlet or "Morning Glory".

Length of Weir - 110 feet (circumference).

Effective Length of Weir - 94 feet (minus baffles).

Crest Elevation - 1050.

Upstream Channel - Not applicable.

Downstream Channel - Discharges into natural streambed.

Type - (emergency) open channel (Route 380). Not indicated on construction drawings.

Width of Channel ≈ 40 feet.

Elevation of Channel Floor ≈ 1070 at overflow.

j. Regulating Outlets. Low flow inlet to outlet conduit with invert elevation 985 at intake tower. Low flow discharge through a 12-inch blow-off located along left bank of stream adjacent to the pump house.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Design Data Availability and Sources.

1. Hydrology and Hydraulics. No design reports are available.

2. Embankment. No design data or engineering analyses are available. However, pre-construction drawings were provided by the owner and PennDER.

3. Appurtenant Structures. No design data or engineering analyses are available.

b. Design Features.

1. Embankment. The contract drawings indicate that the dam embankment is earthfill structure. The slopes vary with elevation as shown in Section 1.3 g. and the crest is approximately 22 feet wide. The dam has a riprap upstream face to elevation 1055 and is seeded from elevation 1055 to elevation 1075. The crest is provided with a 6-inch gravel roadway surface. The downstream face is seeded from the crest to elevation 1000 and is provided with a rock face in the area of the discharge end of the outlet conduit.

Design drawings indicate a cutoff trench, 30 feet wide at the base, was excavated to rock and backfilled with embankment materials. In addition, a concrete cutoff wall apparently extends 5 feet above and below the top of rock from abutment to abutment.

The structure is also served by an emergency spillway (not indicated on available drawings) cut into natural ground on the left abutment. Should the pool level rise to within 5 feet of the dam crest water would begin discharging around the left abutment and would be directed along Pennsylvania Route 380 passing in front of the dam. There appears to be little danger of this discharge causing damage to the embankment.

2. Appurtenant Structures.

a) Spillway. The primary discharge outlet at Beaver Run Dam is a reinforced concrete "Morning Glory" drop inlet spillway. The spillway is equipped with crest baffles to eliminate vortex formation at low flow. The spillway is ungated and its discharge rate cannot be controlled.

b) Outlet Works. The facility is equipped with two 42-inch diameter cast iron conduits, one which reportedly is a direct supply line to Allegheny Ludlum Steel while the other reportedly conveys water to an adjacent treatment facility.

c) Gate House. The gate house is a masonry structure atop a superstructure supported on concrete columns. The facility controls water intake at three separate elevations: 985, 1005, and 1025.

2.2 Construction Reports.

No reports are available.

2.3 Operational Records.

Operational records are available at the water treatment plant located directly west of the dam.

2.4 Other Investigations.

Bankson Engineers compiled the most recent investigative report which is dated April 12, 1978.

2.5 Evaluation.

The available engineering data was considered sufficient to make a general assessment of the structure.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General. The general appearance of the structure and its appurtenances is good.

b. Embankment. The upstream slope of the dam is mantled with 2-foot rock facing covering 18 inches of gravel up to elevation 1055. Above elevation 1055, the upstream face is covered with a thick growth of honeysuckle. The downstream dam slope is seeded with crown vetch and other grasses. Numerous bushes and small trees have also become established on the downstream slope.

Seepage was observed near the intersection of the dam and the right abutment (≃ elevation 1040). The total amount of seepage was estimated to be approximately 5 GPM, however, a small erosion ditch had been cut in this area (see Photographs 6 and 7).

c. Appurtenant Structures.

1. Spillway. The "Morning Glory" spillway appeared to be in satisfactory condition. Efflorescence was observed along the cold joint resulting from raising the spillway in 1962. Reportedly some repair work was performed on the impact block in the spillway, however, access to this portion of the outlet structure could not be attained hence we were not able to observe this remedial work during our investigation.

Discussions with a former water company employee indicated that the outlet structure was also repaired on at least one occasion in the early 1950's. He reported that the concrete had been severely damaged and that holes were patched within the conduit in the top, sides, and bottom of the structure.

The low point in the left abutment which serves as an emergency spillway has apparently been excavated to rock. Much of this low point is currently used as a parking lot and is covered with slag. Water passing over the embankment would flow down Route 380 and enter the natural Beaver Run drainage near the pump house and bridge (see Photograph 2).

2. Gate House. The general condition of the gate house, access bridge, and valves appeared satisfactory. According to a representative of the Water Authority, the valves are in good working order and are periodically maintained. Three valves located within the gate house allow for the removal of water from different elevations within the reservoir. This water discharges into two 42-inch cast iron pipes which pass through the dam beneath the 10-foot diameter extension to the spillway (see Figure 6).

3. Reservoir Area. The slopes adjoining the reservoir varied from gentle to steep and are heavily wooded. No indications of slope distress were observed during the investigation aside from some minor soil sloughing.

4. Downstream Channel. The area immediately downstream consists of a rock-lined channel to a point 200 feet downstream where flow passes beneath a highway bridge on PA Route 380. After passing beneath the bridge, the flow reenters the natural Beaver Run drainage and travels through a narrow, steep sided, wooded valley to a point approximately seven miles downstream before discharging into the Kiskiminetas River.

Just prior to the confluence with the Kiskiminetas River, Beaver Run passes through the community of Paulton, Pennsylvania. Numerous homes are located near the banks of the stream at this point. There are also at least two dwellings located on the hillside about 1000 feet downstream and north of the dam. At least 12 dwellings could conceivably be within the influence of a flood that would result from a breach of the Beaver Run embankment, consequently, a high hazard rating was given to the facility.

3.2 Evaluation.

At the time of inspection, vegetative growth on the dam was not excessive thus permitting an accurate assessment of the surficial condition of the dam. No inspections could be made of the outlet conduit as access is not available through the morning glory and the outlet was partially submerged. Some seepage was observed on the right abutment which should be controlled and assessed.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operational Procedure.

According to water company personnel, there are no established operational procedures at the facility. The crest of the morning glory spillway is at elevation 1050, leaving 25 feet of freeboard to the top of the dam. Excess inflow passes over the morning glory spillway and is discharged into the natural downstream drainage. Two 42-inch diameter cast iron pipes supply water to the Westmoreland County Water Authority System. One of the lines is fitted with a 12-inch diameter blow-off at the base of the dam. The blow-off was discharging at the time of inspection and is used to recharge flow into the downstream area. It is not certain, however, if the supply lines can be used as emergency outlets without some modification. (They may be able to blow-off the supply lines elsewhere in the piping system.)

4.2 Maintenance of Dam.

The dam crest is periodically mowed by water company personnel. The upstream slope is mantled with honeysuckle whereas the downstream slope is a mixture of crown vetch, bushes, and small trees.

4.3 Maintenance of Operating Facilities.

According to water company personnel, the valves in the gate house are maintained on an as-needed basis. The gate controls appeared to be in good working order although they were not operated in our presence.

4.4 Warning System.

There are no formal warning systems in effect at the facility. Operations and maintenance personnel are available on a full-time basis at the filtration plant adjacent to the facility.

4.5 Evaluation.

Although no formal procedures were available, the facility appears well maintained and in good operating order. Filtration plant personnel are in close proximity to the facility on a full-time basis. A formal warning and evacuation plan should be developed.

SECTION 5
HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

No hydrologic or hydraulic data are available with the exception of a graph of reservoir storage capacity versus elevation contained in the contract drawings and enclosed within this report in Appendix F, Figure 1. All other information is reported to have been destroyed while in storage at Harrisburg, Pennsylvania, during the flood of 1972.

5.2 Experience Data.

The ratio "PMF Peak Flow/Drainage Area" was determined using information supplied by the Corps of Engineers, specifically that being a graph of drainage area versus PMF Peak Flow per square mile for the entire Ohio River Basin. Beaver Run Dam has a drainage area of 43.2 square miles and a corresponding PMF equivalent to 40,176 cfs. The size category is "intermediate" and the hazard rating "high". Consequently, the PMF is used as the design storm (as per "Recommended Guidelines for Safety Inspection of Dams").

The Corps of Engineers recommended an alternate method for calculating the PMF based on the following equation:

$$Q_{\text{Beaver Run}} = \left(\frac{\text{Drainage Area Beaver Run}}{\text{Drainage Area Loyalhanna}}\right)^{n} Q_{\text{Loyalhanna}}$$

A value for n was to be obtained by comparing rainfall and discharge data for similar storms at both Beaver Run Dam and Loyalhanna Dam. Research for and persual of available information revealed a lack of sufficient discharge data. As a result, this method was not executed.

5.3 Visual Observations.

The dam and its appurtenances appeared to be in satisfactory condition relative to hydraulics and hydrology considerations.

5.4 Overtopping Potential.

The ratio "PMF Peak Flow/Drainage Area" was determined from an empirical curve supplied by the Corps of Engineers, Baltimore District. The curve used was the Ohio River Basin Curve (see calculations in Appendix C). Based on this curve and a drainage area of 43.2 square miles, Peak PMF Q/A = 930 cfs/sq. mi., and Peak PMF Q = 40,176 cfs. The size category is "intermediate" and the hazard rating "high". Consequently, the SDF used in this analysis is the PMF ("Recommended Guidelines for Safety Inspection of Dams").

Calculations were performed to evaluate the overtopping potential of the dam for existing and design conditions during the PMF.

Based on the curve the inflow volume for this storm is 116,212 acre-feet. This volume of inflow appeared excessive and, as a consequence, an inflow volume based on 26 inches of runoff, that is, 59,904 acre-feet, was used in subsequent calculations.

According to the U. S. Bureau of Reclamation, "Design of Small Dams," to avoid the possibility of siphonic flow conditions the downstream conduit size of a drop inlet spillway is chosen so that it will never flow full beyond the inlet transition. The conduit size is ordinarily selected so that it will not flow more than 75 percent full at the downstream end during maximum discharge. The hydraulic calculations indicate that such a condition is achieved under a head of approximately two feet. At two feet of head, the spillway and outlet works have a combined discharge capacity approximately equal to 1730 cfs. The drop inlet is ungated and consequently flow through it cannot be regulated. A quick comparison shows an outflow capacity of 1730 cfs to be significantly less than the peak PMF inflow, 40,176 cfs. Obviously a large amount of inflowing water must be stored before it can be discharged. As a result, a head of greater than the 2 feet for which the spillway apparently is designed is likely. If the conduit flows at such a stage that the downstream end flows full, both inlet and outlet will be sealed. To forestall siphon action by withdrawal of air would require an adequate venting system. If no venting is provided or if venting is inadequate, a make and break siphon action will attend the flow in the range of discharges approaching full flow conditions. This action is accompanied by erratic discharges, by thumping and vibrations, and by surges at the entrance and outlet of the spillway. Since no design reports pertaining to the spillway are available, it is difficult to analyze its structural integrity. However,

it is sufficient to note at this point that head beyond the design head (assumed to be 1052) is likely to occur and be maintained for a period that may cause concern. Thus, the overall effects of such a condition must be considered.

Considering conditions on maximum head, the primary spillway (morning glory), outlet works, and emergency spillway (Route 380) have a combined discharge capacity approximately equal 17,765 cfs. A comparison of peak inflow to maximum discharge shows a need for some storage capacity in order that excess inflow can be contained until it is safely discharged. Based on normal pool elevation 1050 and the top of dam elevation 1075, the available storage is found to be approximately equal to 40,000 acre-feet. This compares favorably with the storage required of 33,546 acre-feet and consequently, the dam is not expected to overtop when subjected to the PMF.

5.5 Spillway Adequacy.

The spillways associated with this facility are deemed adequate in that they are capable of passing a flood of PMF magnitude.

SECTION 6
EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Embankment. Based on visual observations, the embankment appeared to be in satisfactory condition. A small amount of seepage was observed to be issuing from the area of the embankment-right abutment contact (elevation ≈1040). The total flow at this point was estimated to be equal to approximately 5 GPM, however, a small erosion ditch had been cut in this area (see Photograph 7).

b. Appurtenant Structures. Based on a visual assessment, the spillway inlet, the gate house, and the access bridge appeared to be in satisfactory condition. According to water company personnel, however, the outlet conduit was once pressure grouted and also has required repair on at least one other occasion after approximately 18 inches of water was discharging over the spillway. Water was reportedly trapping air within the outlet and periodically expelling water in slugs from the discharge end. A retired water company employee reported that this water was expelled from the outlet to the bridge on Route 380, a distance of at least 200 feet. The ex-employee claimed that cracks developed within the outlet and that large chunks of concrete became dislodged from the structure. It appears likely then that a make and break siphoning action develops within the outlet pipe during critical water levels and that this action is sufficient to effect the structural integrity of the outlet system.

6.2 Design and Construction Techniques.

a. No soils investigation or stability analyses reports were available for review, however, contract drawings were provided through the PennDER. It should be pointed out that the available drawings are pre-construction drawings and not as-builts. The designers, Gannett, Fleming, Corddry, and Carpenter, Inc., indicated that all of the calculations, as-built drawings, etc., concerning this structure were lost during a flood in the early 1970's.

b. Appurtenant Structures. No information concerning the design or construction techniques of the appurtenant structures was available. Available pre-construction drawings show the details of the outlet system and its appurtenances.

6.3 Past Performance.

No records of past performance were available with the exception of reported 18-inch and 3-foot depths of water over the spillway during the "Hazel" storm of 1954 and the "Agnes" storm of 1972. Remedial repairs to the outlet were necessary following the Hazel storm and additional repairs were required at a later date (possibly following the Agnes storm).

6.4 Seismic Stability.

The dam is located in Seismic Zone No. 1 and it is thought that the static stability is sufficient to withstand minor earthquake induced dynamic forces. However, no calculations or investigations, etc., were performed to confirm this belief.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The visual inspection and operational history of the dam indicate that the structure is in good condition, aside from some minor seepage near the embankment-right abutment contact (elevation ≈1040). An evaluation of the outlet works, on the other hand, indicated that although the facility is capable of passing and storing the PMF, there may be some serious structural problems involving the morning glory outlet system. Apparently the outlet experiences siphoning action and resulting thumping, vibration and erratic flow when passing from weir control to outlet control conditions. The outlet has reportedly required repair following at least one and possibly two episodes of high flow.

b. Adequacy of Information. The available information was considered sufficient to make a general assessment of the project.

c. Urgency. It is recommended that the remedial measures listed below be implemented immediately.

d. Necessity for Additional Investigations. An additional investigation is considered necessary to evaluate the integrity of the morning glory spillway system, flow along the right abutment, and general phreatic levels within the embankment.

7.2 Recommendations/Remedial Measures.

a. It is recommended that the owner retain the services of a registered professional engineer, experienced in hydraulic and hydrologic design, to evaluate the condition of the spillway outlet and to make any modifications deemed necessary to provide for safe and unattended flow through the outlet system.

b. It is recommended that the owner gage the flow which is issuing from the area of the embankment-right abutment contact (elevation ≈1040). If the condition worsens, remedial measures should be implemented. Provisions to protect the embankment area downhill of the seep from further erosion should also be undertaken.

c. The owner should install observation wells in the embankment to establish the phreatic surface and to project the phreatic surface at maximum pool level. The results of the monitoring program should be evaluated by a registered professional engineer experienced in the design and construction of earthen embankments.

d. It is also recommended that a warning system be developed to allow for the safe evacuation of downstream inhabitants in the event of an unusually heavy rainfall.

e. The dam should be inspected on a periodic basis to check for hazardous conditions which might develop.

f. The owner should remove the overgrowth on the embankment slopes and implement a regular maintenance program.

APPENDIX A

ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Beaver Run Dam

ID # NDI # PA-484; PennDER# 65-114

ITEM	REMARKS	SHEET 1

AS-BUILT DRAWINGS Not Available
Construction Drawings (not as-builts) are available from the owner and from PennDER files (Drawings are numbered 1 through 17). Some of these drawings are reproduced in Appendix F - Figures.

REGIONAL VICINITY MAP Drawing 1 of 17--" Location Plan "

CONSTRUCTION HISTORY
Compiled by GAI from available correspondence and data

TYPICAL SECTIONS OF DAM
Drawing 4 of 17 "General Plan"

Drawing 6 of 17 "Miscellaneous Sections"

OUTLETS - PLAN Drawing 6 of 17

- DETAILS Drawings 7,8,9,10,14,15, of 17 "Miscellaneous Details"

- DISCHARGE RATINGS Not Available

RAINFALL/RESERVOIR RECORDS Available at treatment plant directly across from dam.

ITEM	REMARKS	ID # PA-484	SHEET 2

DESIGN REPORTS All reports and data compiled by Gannett, Fleming, Cordory, and Carpenter, Inc. that were used in the design and construction of this facility were destroyed in storage at Harrisburg during the flood of 1972.

GEOLOGY REPORTS Not Available

DESIGN COMPUTATIONS Not Available
HYDROLOGY & HYDRAULICS
DAM STABILITY
SEEPAGE STUDIES

MATERIALS INVESTIGATIONS
BORING RECORDS
LABORATORY Drawing 4 of 17 "Plan of Dam"
FIELD Drawing 5 of 17 "Log of Drill Holes"

POST-CONSTRUCTION SURVEYS OF DAM Survey report by Morris Ramsey, P. E.
Dated 5-25-54

BORROW SOURCES Drawing 2 of 17 "Reservoir Plan"
(Depicts borrow locations)

ITEM	REMARKS	ID # PA-484	SHEET 3

MONITORING SYSTEMS	None
MODIFICATIONS	Spillway crest raised from 1045 to 1050 in 1962. No drawing showing this modification is available.
HIGH POOL RECORDS	Ref: Bankson Report - Maximum flood level to date has been 1053 feet which is 3 feet above spillway crest. No date given.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Bankson Report dated 4-12-78
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None
MAINTENANCE OPERATION RECORDS	Not Available

ITEM	REMARKS	ID # PA-484	SHEET 4
SPILLWAY PLAN	Drawing 6 of 17	"General Plan"	
SECTIONS	Drawing 10 of 17	"Drop Inlet"	
DETAILS	Drawings 7, 8, 9, 11 of 17	"Outlet Details"	
OPERATING EQUIPMENT PLANS & DETAILS	Drawing 15 of 17	"Intake Tower, Miscellaneous Details"	
	Drawing 17 of 17	"Intake Superstructure, Sections and Details"	

NDI# PA-484

CHECK LIST ID # PENNDER# 65-114

HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 43 square miles.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 34,000 acre-feet at ele. 1050.

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Not known.

ELEVATION MAXIMUM DESIGN POOL: 1075.

ELEVATION TOP DAM: 1075.

SPILLWAY DATA:

a. Crest Elevation 1050 (primary); 1070 (emergency).
b. Type Morning glory; natural.
c. Weir Length 110 feet; 40 feet.
d. Channel Length N/A; N/A.
e. Location Spillover Upstream of center; left abutment.
f. Number and Type of Gates None; none.

OUTLET WORKS:

a. Type Two 42-inch diameter cast iron conduits.
b. Location Station 6+40.
c. Entrance Inverts 985.0.
d. Exit Inverts 983.
e. Emergency Draindown Facilities Two 42-inch cast iron conduits.

HYDROMETEOROLOGICAL GAGES:

a. Type Rainfall gauge.
b. Location at filtration plant directly across from dam.
c. Records (same as above).

MAXIMUM NON-DAMAGING DISCHARGE: Not known.

APPENDIX B

VISUAL CLASSIFICATION

CHECK LIST
VISUAL INSPECTION
PHASE 1

DAM NAME Beaver Run Dam COUNTY Westmoreland STATE Pa. ID # NDS #Pa. - 484 PennDER - 65-114

TYPE OF DAM Earth Fill HAZARD CATEGORY High

DATE(S) INSPECTION 11 May 78 WEATHER Clear TEMPERATURE 60°- 70°

POOL ELEVATION AT TIME OF INSPECTION 1048 M.S.L. TAILWATER AT TIME OF INSPECTION 976 M.S.L.

INSPECTION PERSONNEL:

		Other Participants
J. P. Nairn	Tom Vayansky (PennDER)	Ken Baker (Municipal Authority of Westmoreland County)
K. H. Khilji		
D. Bonk		Bob Smith)Municipal Authority of Westmoreland County)
B. M. Mihalcin	B. M. Mihalcin	RECORDER

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None Evident	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None Evident	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Leakage on right abut. starting ≈ 34' below crest (11' below pool level) and continues to toe. Slight sloughing caused by erosion due to leakage - all in natural slope.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Good	
RIPRAP FAILURES	None Evident Vegetation: u/s - Honeysuckle (dense) d/s - Partial honey/briars/grass	- recently applied crown vetch on left side/just starting to catch

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Right abut/embankment leak ≈ 34' below crest Left abutment--O.K.	
ANY NOTICEABLE SEEPAGE	Right abutment near intersection of dam and abutment @ Ele. ≈ 1040	
STAFF GAGE AND RECORDER	Staff gage on gate house Water level @ time of inspection - 1047.8	
DRAINS	None Evident	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Some spalling on bridge deck Efflorescence observed @ cold jt. where Morning Glory spillway was raised	
INTAKE STRUCTURE	Morning Glory spillway	
OUTLET STRUCTURE	Have repaired leakage and deterioration in Morning Glory and 10 foot outlet pipe at impact block 12" blow-off on 42 inch supply line--operating at time of inspection	
OUTLET CHANNEL	Slight cracking in outlet structure wingwalls - cracking previously repaired Generally in good condition	
EMERGENCY GATE	None	

UNGATED SPILLWAY ID # PA-484 SHEET 4

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Morning Glory Spillway	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	Reinforced concrete pipe to concrete chute--good shape. Emptying into rock lined channel≈ 200' (to Rt. 380 bridge)	
BRIDGE AND PIERS	Bridge over morning glory spillway access to gate house.	

UNGATED SPILLWAY (Emergency Spillway) ID # PA-484 SHEET 4a

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	None. Overflow at low point on left abutment - Flow directed down Route 380.	
APPROACH CHANNEL	Natural - Low point in left abutment.	
DISCHARGE CHANNEL	Flow discharged down Route 380 and directed into Beaver Run channel.	
BRIDGE AND PIERS	None.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL		
	N/A	
APPROACH CHANNEL		
	N/A	
DISCHARGE CHANNEL		
	N/A	
BRIDGE AND PIERS		
	N/A	
GATES AND OPERATION EQUIPMENT		
	N/A	

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	Venturi on blow-off to stream Rainfall gauge @ filtration plant across Rt. 380	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHERS	None	

Peabody Road

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	gentle to moderate	
SEDIMENTATION	Minor amounts of sedimentation at inlets-- no surveys conducted to gage actual amount	

DOWNSTREAM CHANNEL ID # PA-484 SHEET 8

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Rock lined channel from the toe of the dam to Rt. 380. Beyond that point re-enters the natural drainage. No major obstructions	
SLOPES	Slopes surrounding the reservoir vary between gentle and steep Moderate slopes being the norm	
APPROXIMATE NO. OF HOMES AND POPULATION	Perhaps two homes on hillside just downstream of the dam would be effected. Also at least ten homes in the community of Paulton (≈ 7 miles downstream) could conceivably be affected. At least 30 people.	

APPENDIX C

HYDROLOGY AND HYDRAULICS

SUBJECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-6-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 6-7-78 SHEET NO. 1 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

BEAVER RUN DAM

DAM LOCATION - VANDERGRIFT QUADRANGLE

DRAINAGE AREA - MURRAYSVILLE QUADRANGLE
SALTSBURG QUADRANGLE
SLICKVILLE QUADRANGLE
GREENSBURG QUADRANGLE
NEW KENSINGTON EAST QUADRANGLE

DAM STATISTICS

MAXIMUM HEIGHT		= 91 FT
CAPACITY	(REF 6, DRWG 1)	= 34,000 AC-FT
SURFACE AREA (EL 1050)	(REF 6, DRWG 1)	= 1250 ACRES
DRAINAGE AREA	(REF 4)	= 43.2 SQ.MI.
DRAINAGE AREA	(PLANIMETER CHECK)	= 41.6 SQ. MI.

REF 1 : "STANDARD HANDBOOK FOR CIVIL ENGINEERS" by F.S. MERRITT

REF 2 : "DESIGN OF SMALL DAMS" U.S. BUREAU OF RECLAMATION 2ND ED

REF 3 : TELEPHONE MEMO 4-26-78 GRT TO M. KANOWITZ

REF 4 : "WATER RESOURCES BULLETIN; DAMS, RESERVOIRS, AND LAKES" by PA. DEPT OF FORESTS AND WATERS FOR OHIO RIVER BASIN

REF 5 : "RECOMMENDED GUIDELINES FOR SAFETY INSPECTION" by DEPT OF ARMY, OFFICE OF CHEIF ENGINEER APPENDIX D

REF 6 : CONTRACT DRAWINGS by GANNETT, FLEMING, CORDORY & CARPENTER

ECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 5-17-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 6-7-78 SHEET NO. 2 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

SIZE CLASSIFICATION

DAM SIZE – INTERMEDIATE (BASED ON HEIGHT AND CAPACITY AS OUTLINED IN REF 5, TABLE 1)

HAZARD RATING – HIGH (REF 5, TABLE 2)
(POSSIBLE LOSS OF LIFE GREATER THAN 3)

REQUIRED SDF - PMF (REF 5, TABLE 3)

DETERMINE PMF (FOLLOW PROCEDURE OUTLINED IN REF 3)

(REF 3) $Q_{\text{BEAVER RUN}} = \left[\frac{\text{DRAINAGE AREA FOR BEAVER RUN}}{\text{DRAINAGE AREA FOR LOYALHANNA}}\right]^{n} Q_{\text{LOYALHANNA}}$

(REF 3) $Q_{\text{LOYALHANNA}}$ (PMF) = 145,000 CFS
(REF 4) DRAINAGE AREA FOR LOYALHANNA = 290. SQ. MI.
(REF 4) DRAINAGE AREA FOR BEAVER RUN = 43.2 SQ. MI.

NOTE: STREAM DATA FOR BEAVER RUN DAM ARE NOT AVAILABLE, THEREFORE A VALUE FOR n CANNOT BE DETERMINED BASED ON STREAM FLOW COMPARABLE DATA AS RECOMMENDED IN REF 3.

RECOMMENDED RANGE OF n $0.5 < n < 0.8$

SUBJECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 5-17-78 PROJ. NO. 78-501-424

CHKD. BY JTS DATE 6-7-78 SHEET NO. 3 OF 22

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

$$Q_{BEAVER\ RUN} = \left[\frac{43.7}{290.0}\right]^{0.5<n<0.8} (145{,}000\ CFS)$$

$$31{,}611\ CFS < Q_{BEAVER\ RUN}\ (PMF) < 55{,}964\ CFS$$

(FROM INCLOSURE 4 OHIO) $Q/A = 930\ CFS/SQ.MI$ REF: CORPS OF
" $Q = 40176\ CFS$ ENGINEERS
" TOTAL TIME OF FLOW = 70 CURVES

CALCULATION OF "MORNING GLORY" DISCHARGE CAPACITY

TO AVOID THE POSSIBILITY OF SIPHONIC FLOW CONDITIONS, THE DOWNSTREAM CONDUIT SIZE FOR ORDINARY DESIGNS (AND ESPECIALLY FOR THOSE WITH HIGHER HEADS) IS CHOSEN SO THAT IT WILL NEVER FLOW FULL BEYOND THE INLET TRANSITION. TO ALLOW FOR AIR BULKING, SURGING, ETC., THE CONDUIT SIZE IS ORDINARILY SELECTED SO THAT IT WILL NOT FLOW MORE THAN 75 PERCENT FULL (IN AREA) AT THE DOWNSTREAM END AT MAXIMUM DISCHARGE. (REF 2, PG 424, COL 2, PAR 3)

SPILLWAY STATISTICS

LENGTH (HORIZONTAL PORTION)	$L \approx 305'$
DEPTH (LENGTH OF THROAT)	$P \approx 53'$
OUTER RADIUS OF CREST	$R_S = 17.5'$
RADIUS AT OUTLET	$r = 5.0'$
SLOPE	$s = 0.005$

(REF 7, DRWG 6)

ECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 5-17-78 PROJ. NO. 78-501-484
CHKD. BY JTS DATE 6-7-78 SHEET NO. 4 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

CALCULATE FLOW THROUGH HORIZONTAL PORTION OF CONDUIT (REPRESENTS MAXIMUM DESIGN DISCHARGE)

USE MANNING'S FORMULA (OPEN CHANNEL FLOW)

$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

(REF 1, pg 21-21) EQ 21-33a

V = VELOCITY OF FLOW = SOLVE FOR
S = SLOPE = 0.005
n = FRICTION COEFFICIENT

FOR CONCRETE PIPE WITH GOOD WORKMANSHIP
n RANGES FROM 0.012 - 0.014 (REF 1, TABLE 21-4)

n = 0.012 (VALUE CHOSEN TO YIELD HIGHEST DISCHARGE)

R = HYDRAULIC RADIUS

$$R = \frac{\text{AREA OF FLOW}}{\text{WETTED PERIMETER}} = 2.97 \text{ FT}$$

(REF 2, TABLE B-3, APPENDIX B)
ALSO SHEET 5

ECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-1-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 6-7-78 SHEET NO. 5 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

STEPS TAKEN TO OBTAIN THE VALUE OF 2.97 AS THE HYDRAULIC RADIUS ON SHEET 4.

GIVEN A = AREA OF FLOW $= (0.75)(\pi)(5.0')^2$

$A = 58.90$

D = DIAMETER OF PIPE = 10FT

$A/D^2 = 0.5890$

GO TO REF 2, APPENDIX B-3 AND LOOK UP THIS VALUE UNDER THE COLUMN A/D^2. IT FALLS BETWEEN THE VALUES 0.5872 AND 0.5964.

LOOK UNDER THE COLUMN r/D WHERE r IS EQUAL TO THE HYDRAULIC RADIUS. THE VALUE OF r/D FALLS BETWEEN THE VALUES OF 0.2962 AND 0.2975 WHICH CORRESPOND TO THE VALUES FOUND PREVIOUSLY AS THE RANGE OF VALUES FOR A/D^2.

INTERPOLATING YIELDS A VALUE OF r EQUAL TO 2.97 FT.

ECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-1-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 6-7-78 SHEET NO. 6 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

$$V = \frac{1.486}{(0.012)}(2.97)^{2/3}(0.005)^{1/2} =$$

$V = 18.1$ fps

$$Q = VA = (18.1 \text{ Ft/s})(0.75)(\pi)(5.0 \text{ Ft})^2 =$$

$Q = 1066$ CFS

CALCULATE THE HEAD REQ'D TO PRODUCE DISCHARGE Q

$$Q = C_o L H^{3/2} = C(2\pi R_s) H_o^{3/2}$$ (REF 2, pg 415, EQ 28)

Q = FLOW OVER SPILLWAY CREST = 1066 CFS
H_o = DESIGN HEAD = SOLVE FOR
C_o = CONSTANT (REF 2, FIG 283)

$R_s = 17.5$ Ft (SHEET 3) HOWEVER DRWG 10 OF 16 OF THE CONTRACT DRAWINGS SHOWS 12 BAFFLE WALLS WITH 16 INCH WIDTHS ATOP THE SPILLWAY. THUS L IS EFFECTIVELY REDUCED BY AN AMOUNT EQUAL TO 12 (16 INCH) = 16 Ft

$L = (2\pi)(17.5 \text{ Ft}) - 16 \text{ FT} = 94 \text{ FT}$

ECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-1-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 6-7-78 SHEET NO. 7 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

C_o IS DETERMINED BY TRIAL & ERROR

H_o	H_o/R_s	C_o	Q
4.0	0.23	3.85	2895
3.0	0.17	3.92	1915
2.0	0.11	3.98	1058

COMPILED FOR $P/R_s \geq 2.0$

THUS THE ABOVE TABLE SHOWS CONCLUSIVELY THAT THE DESIGN FLOW OCCURS UNDER AN APPROXIMATE HEAD OF 2 FEET. THIS IS THE MAXIMUM HEAD DESIGNED TO AVOID SIPHON FLOW

SINCE THERE IS NO WAY OF CONTROLLING FLOW THROUGH THE DROP INLET, DISCHARGE UNDER MAXIMUM HEAD MUST BE CONSIDERED. THIS IS CALCULATED STARTING ON SHEET 11.

MAXIMUM POSSIBLE HEAD = (EL TOP OF DAM - EL TOP OF SPILLWAY) + (DEPTH OF THROT

$H_{MAX} = (1075 - 1050)\,FT + (53\,FT) = 78\,FT$

(REF: DRWG 10)

PROJECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-1-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 6-7-78 SHEET NO. 8 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

CALCULATE DISCHARGE CAPACITY OF TWO 42 INCH LINES WHICH MAKE UP THE OUTLET WORKS. THIS IS TO BE DONE FOR HEAD AT EL 1052 WHICH IS THE DESIGN HEAD TO AVOID SIPHON FLOW IN SPILLWAY.

FOR THIS ANALYSIS A CONDITION OF FULL GRAVITY FLOW IS ASSUMED. THE EFFECTS OF PUMPS AND OTHER OPERATING APPARATUS HAS BEEN NEGLECTED DUE TO A LACK OF CONSISTENT INFORMATION THAT HAS BEEN GATHERED. IN OTHER WORDS, CONTRACT DRAWINGS AND DATA OBTAINED FROM RESPONSIBLE PERSONEL HAVE MANY INCONSISTENCIES. THE OUTLET ANALYSIS REPRESENTS MERELY A ROUGH ESTIMATE OF THEIR CAPACITIES

INLET ELEVATION = 985 (REF: DRWG 7)
OUTLET ELEVATION = 983 (FIELD VERIFIED)
CONDUIT LENGTH $\simeq$ 550 Ft (INLET TO OUTLET)
SEE NOTE SHEET 12

USE BENOULLI'S EQUATION (REF 1, EQ 21-11)

$$Z_1 + P_1/w + V_1^2/2g = Z_2 + P_2/w + V_2^2/2g + h_f + h_e$$

DATUM IS TAKEN AT CENTER OF OUTLET

Z_1 = HEIGHT OF INLET ABOVE DATUM = 2
Z_2 = " " OUTLET " " = 0
P_1/w = PRESSURE HEAD AT INLET (1052 - 985) = 67'
P_2/w = " " " OUTLET = 0
V_1 = VELOCITY AT INLET = 0
V_2 = " " OUTLET = SOLVE FOR

JECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-1-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 6-7-78 SHEET NO. 9 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

$$h_f = \frac{f L V^2}{2gD}$$ (REF 1, EQ 21-30)

h_f = HEAD LOSS DUE TO FRICTION
L = LENGTH OF CONDUIT = 550'
D = DIAMETER OF CONDUIT (REF: DRWG 10) = 3.5'
g = GRAVITATIONAL CONSTANT = 32.2 FT/SEC²

f = FRICTION COEFFICIENT (BASED ON A ROUGHNESS COEFFICIENT OF 0.00085 FOR C.I. PIPE) REF 1, TABLE 21-3

$\varepsilon/D = 0.00024$

FOR REYNOLD'S NUMBER = 1.0×10^7 $f \approx 0.014$

(REF 1, FIG 21-19)

$$h_e = K_E \frac{V^2}{2g}$$ (REF 1, EQ 21-42)

h_e = HEAD LOSS AT ENTRANCE
K_E = 0.50 (REF 1, TABLE 21-7)

THUS

$$2' + 67' + 0 = 0 + 0 + \frac{V^2}{2(32.2)} + \frac{(0.014)(550)V^2}{(3.5)(2)(32.2)} + \frac{0.50\,V^2}{2(32.2)}$$

SUBJECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-1-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 6-7-78 SHEET NO. 10 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

$$69' = 0.016V^2 + 0.034V^2 + 0.008V^2$$

$$69'/0.058 = V^2$$

$$V = 34.5 \text{ fps}$$

$$Q_{42} = VA = (34.5 \text{ FT/SEC})(\pi)(1.75')^2$$

$$Q_{42} \leq 332 \text{ CFS}$$

$$2(Q_{42}) = 2(332 \text{ CFS}) = 664 \text{ CFS} \quad \text{TOTAL OUTLET CAPACITY}$$

TOTAL DESIGN DISCHARGE CAPACITY =
(TWO 42 INCH OUTLETS PLUS DROP INLET AT 75%)

$$Q_{TOTAL\ DESIGN} \leq 664 \text{ CFS} + 1066 \text{ CFS} \leq 1730 \text{ CFS}$$

NOTE: NOMINAL LENGTHS OF 550 FEET WERE ASSIGNED TO EACH PIPE FOR THE PURPOSE OF THESE CALCULATIONS. THIS IS THE APPROXIMATE DISTANCE FROM INTAKE TO BLOW-OFF FOR ONE OF THE CONDUITS. CONSEQUENTLY, THERE ARE FRICTION LOSSES WHICH ARE UNACCOUNTED FOR ALONG WITH LOSSES AT ELBOWS AND VALVES. THESE ARE NOT INCLUDED HERE AS THEY DO NOT LEND FAIR SIGNIFICANCE TO THE OUTCOME. ADDITIONAL HEAD LOSSES WOULD MERELY REDUCE THE DISCHARGE CAPACITY CALCULATED. THUS THE CALCULATIONS INVOLVING OUTLET WORKS WERE APPROACHED LIBERALLY IN ORDER THAT A ROUGH FIGURE COULD BE ARRIVED AT FOR SOME DEGREE OF REFERENCE.

SUBJECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-1-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 6-7-78 SHEET NO. 11 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

AS A FURTHER CHECK ON THE SPILLWAYS ABILITY TO PASS PMF, DISCHARGE UNDER MAXIMUM HEAD IS CONSIDERED. FULL FLOW IS GOVERNED BY CONTROL AT THE OUTLET, THE HEAD - DISCHARGE RELATIONSHIP CAN BE DETERMINED BY THE APPLICATION OF BERNOULLI'S THEOREM. IF THE OUTLET DISCHARGES INTO A CHANNEL SO THAT THE OUTFLOWING JET IS SUPPORTED, THE EQUATION IS AS FOLLOWS:

$$\frac{H}{D_1} + \frac{L}{D_1}\sin\theta - 1.0 = 0.0252\left[\left(1 + K_e + f\frac{L_1}{D_1}\right)\left(\frac{Q}{D_1^{5/2}}\right)^2\right]$$

(REF 2, PG 433, EQ 33)

WHERE

H/D_1 = PRESSURE HEAD

L_1/D_1 = HEAD LOSS DUE TO ΔZ OVER THE CONDUIT LENGTH

$\sin\phi$ = SLOPE OF CONDUIT = 0.005

1.0 = CONSTANT DEFINING DISCHARGE INTO A CHANNEL WHERE OUTFLOW JET IS SUPPORTED

K_e = 0.5 (TYPICAL) (REF 2, PG 434)

f = 0.0145 (BASED ON MANNINGS n OF 0.013 FOR CONCRETE PIPES (REF 1, PG 21-22, TABLE 21-4) AND D = 10FT)
ALSO REF 2, PG 564, FIG B-7

NOTE: A MAJOR ASSUMPTION IN THIS ANALYSIS IS THAT UNDER VERY HIGH HEAD SUCH AS THE CASE IS HERE, WEIR CREST FLOW NO LONGER GOVERNS AND CONSEQUENTLY THE EQUATION $Q = CLH^{3/2}$ IS INVALID

JECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-1-78 PROJ. NO. 78-501-4841

CHKD. BY JTS DATE 6-7-78 SHEET NO. 12 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

SOLVE FOR Q

$$\frac{78}{10} + \frac{(305)}{(10)}(0.005) - 1.0 = (0.0252)\left[1 + (0.5) + (.0145)\frac{(305)}{(10)}\right]\left[\frac{Q}{(10)^{5/2}}\right]^2$$

$$6.95 = (0.05)\left[\frac{Q}{316.23}\right]^2$$

$$\frac{(6.95)}{(0.05)}^{1/2}(316.23) = Q$$

$Q_{MAX} = 3728$ CFS

JECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-6-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 6-7-78 SHEET NO. 13 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

CALCULATE APPROXIMATE OUTLET DISCHARGE UNDER MAXIMUM HEAD CONDITIONS (REF: SHEET 7)

USE BERNOULLI'S EQUATION AGAIN (ONLY PRESSURE HEAD VARIES)

P_1/w = PRESSURE HEAD AT INLET (1075 - 985) = 90'

$z + 90 + 0 = 0.058 V^2$

$92'/0.058 = V^2$

$V = 39.8$ FPS

$Q = VA = (39.8 \text{ FT/S})(\pi)(1.75')^2 =$

$Q_{MAX} \leq 383$ CFS

TOTAL MAXIMUM DISCHARGE CAPACITY

$2(Q_{HZ\,MAX}) + Q_{SPILLWAY\,MAX} \leq 2(383) + 3728$ CFS

$Q_{TOTAL} \leq 4494$ CFS

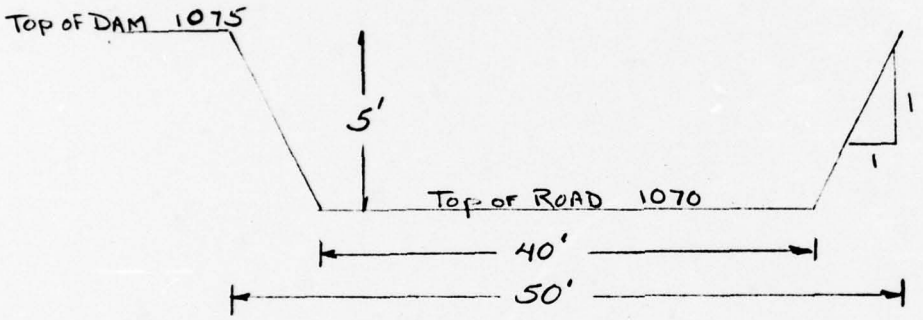
ECT DAM SAFETY INSPECTION
BEAVER RUN RESERVOIR

BY DLB DATE 7-13-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 7-13-78 SHEET NO. 14 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

CONSIDER THE ADDITIONAL DISCHARGE PROVIDED BY ROUTE 380 WHEN UTILIZED AS A SPILLWAY



[APPROXIMATE DIMENSIONS]
(FIELD MEASURED)
(SLOPES ASSUMED)

USE MANNING'S FORMULA FOR OPEN CHANNELS

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$ (REF 1, EQ 21-90)

Q = QUANTITY OF FLOW
W.P. = WETTED PERIMETER = $40' + 2\left[(5')^2 + (5')^2\right]^{1/2}$ = 54.14 FT
A = AREA OF FLOW = (5)(45) = 225 FT²
S = CHANNEL SLOPE $\cong$ 4% = 0.04
n = MANNINGS COEFFICIENT (REF 1, TABLE 21-11) = 0.013
R = HYDRAULIC RADIUS $[(5)(45)/(54.14)]^{2/3}$ = 2.58

IECT DAM SAFETY INSPECTION
BEAVER RUN RESERVOIR

BY DLB DATE 7-13-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 7-13-78 SHEET NO. 15 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

$$Q = \frac{1.486}{(.013)} (225)(2.58)(0.04)^{1/2}$$

$Q = 13,271$ CFS

MAXIMAM DISCHARGE = DROP INLET + OUTLET CONDUITS + EMERG. SPILLWAY

CAPACITY OF OUTLETS = 766 CFS (SHEET 13)

CAPACITY OF DROP INLET = 3728 CFS (SHEET 12)

CAPACITY OF EMERGENCY SPILLWAY = 13,271 CFS

TOTAL DISCHARGE = (766 + 3728 + 13,271) CFS = 17,765 CFS

CALCULATE AVAILABLE STORAGE

STORAGE CAPACITY (@ NORMAL POOL EL 1050) = 34,000 AC-FT
STORAGE CAPACITY (@ TOP OF DAM EL 1075) = 74,000 AC-FT
} REF: DRWG 1

STORAGE AVAILABLE = 40,000 AC-FT

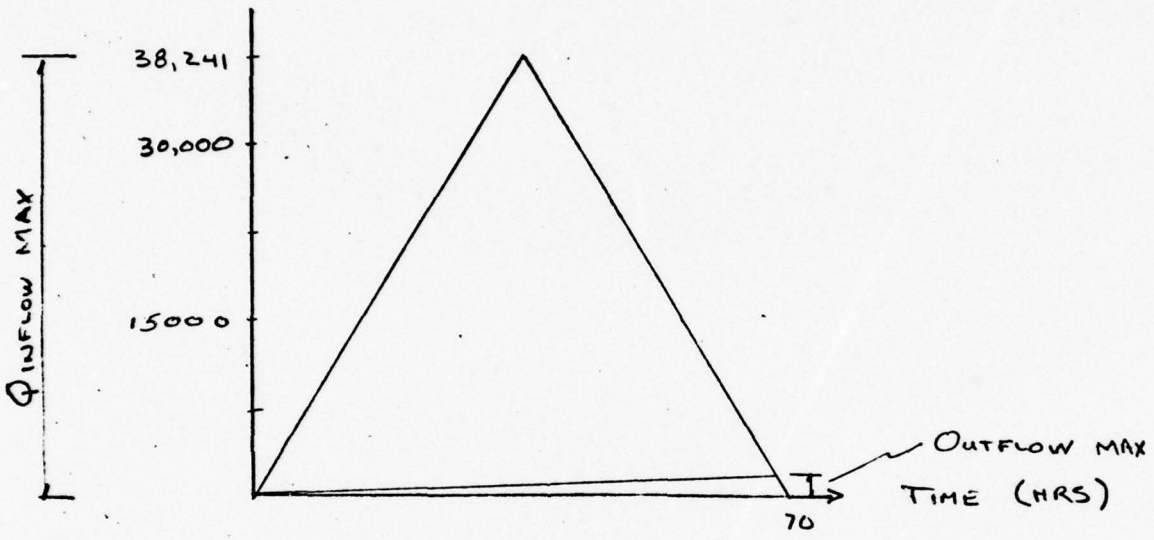
ECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 5-17-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 6-7-78 SHEET NO. 16 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

DEVELOP INFLOW HYDROGRAPH



TOTAL VOLUME OF FLOW FROM ABOVE HYDROGRAPH

$$V = \tfrac{1}{2} Q_{IN\,MAX} \cdot TIME$$

$$= \tfrac{1}{2}(40,176\ CFS)(70\ HRS)(3600\ SEC/HR)(1\ ACRE/43560\ FT^2)$$

$$V = 116,212\ ACRE\text{-}FT$$

JECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-24-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 7-13-78 SHEET NO. 17 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

VOLUME OF INFLOW = 116,212 AC-FT (SHEET 16)

DETERMINE THE AVERAGE RAINFALL IN INCHES REQUIRED TO PRODUCE THE ABOVE INFLOW VOLUME.

$$\frac{(116{,}212 \text{ AC-FT})}{(43.2 \text{ SQ. MI})} (1 \text{ SQ MI}/640 \text{ ACRES})(12 \text{ IN/FT}) = 50.4 \text{ INCHES}$$

VOLUMES PRODUCED BY RAINFALLS IN EXCESS OF 26 INCHES MUST BE RECALCULATED USING 26 INCHES AS AN UPPER BOUND

$$26 \text{ INCHES} \frac{(43.2 \text{ SQ. MI})}{(12 \text{ IN/FT})} (640 \text{ ACRES/SQ. MI}) = 59{,}904 \text{ AC-FT}$$

VOLUME OF INFLOW (RECALCULATED) = 59,904 AC-FT

NOTE: Q_{IMAX} REMAINS CONSTANT
STORM DURATION DECREASES IN ACCORDANCE WITH THE DECREASE OF INFLOW VOLUME

$$\text{STORM DURATION} = \frac{(59{,}904 \text{ AC-FT})(2)(43{,}560 \text{ FT}^2/\text{ACRE})}{(3600 \text{ SEC/HR})(40{,}176 \text{ CFS})} = 36.1 \text{ HRS}$$

JECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-24-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 7-13-78 SHEET NO. 18 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

USING SHORT CUT METHOD SUGGESTED BY NAD

MAXIMUM HEAD CONDITIONS

MAXIMUM DISCHARGE RATE $\cong$ 17,765 CFS (SHEET 15)

MAXIMUM PEAK INFLOW $\cong$ 40,176 CFS (SHEET 3)

$$P = \frac{\text{MAXIMUM DISCHARGE RATE}}{\text{MAXIMUM PEAK INFLOW}} = \frac{17,765 \text{ CFS}}{40,176 \text{ CFS}} = 0.44$$

$$\therefore (1-P) = \frac{\text{REQ'D RESERVOIR STORAGE}}{\text{VOLUME OF INFLOW}} = (1 - 0.44) = 0.56$$

REQ'D RESERVOIR STORAGE = (0.56)(59,904 AC-FT) = 33,546 AC-FT

STORAGE AVAILABLE (40,000 AC-FT) > STORAGE REQ'D (33,546 AC-FT)
(SHEET 15) ✓

SUBJECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-24-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 7-13-78 SHEET NO. 19 OF 22

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

CALCULATE THE PERCENT PMF THAT IS PASSABE (DESIGN HEAD CONDITIONS) (SHEETS 3 THRU 10)

$$P = \frac{\text{MAXIMUM DISCHARGE RATE}}{Q_{I_{MAX}}} = \frac{3728\ CFS}{Q_{I_{MAX}}}$$ (SHEET 12)

$$(1-P) = \frac{\text{AVAILABLE STORAGE}}{\text{VOLUME OF INFLOW}}$$

$$1 - \frac{3728\ CFS}{Q_{I_{MAX}}} = \frac{40{,}000\ AC\text{-}FT}{\frac{1}{2}(Q_{I_{MAX}})(3600\ SEC/HR)(36.1\ HRS)(1\ ACRE/43{,}560\ FT^2)}$$

$$1.49\ Q_{I_{MAX}} - 5555 = 40{,}000$$

$$1.49\ Q_{I_{MAX}} = 45{,}555$$

$$Q_{I_{MAX}} = 30{,}574\ CFS$$

PMF PEAK INFLOW (MAXIMUM INFLOW) = 40,176 CFS (SHEET 3)

$$Q_{I_{MAX}} = 76.1\%\ PMF$$

SUBJECT: DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-8-78 PROJ. NO. 78-501-484

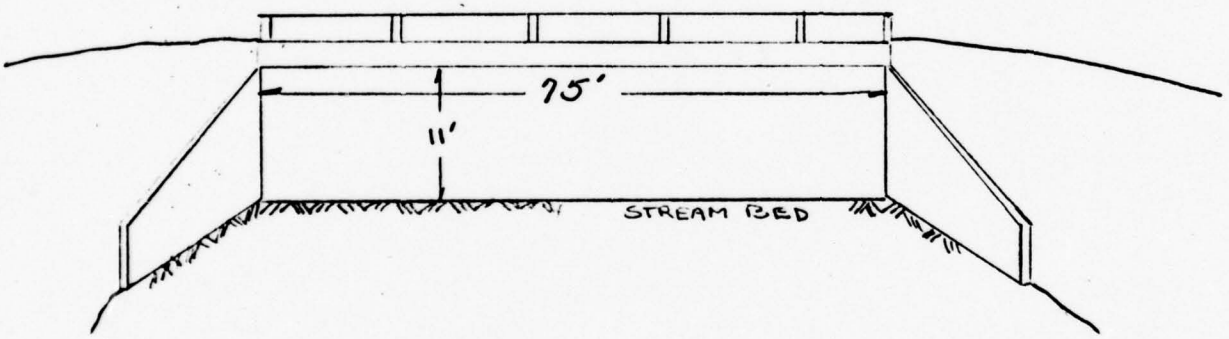
CHKD. BY JTS DATE 6-8-78 SHEET NO. 20 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

CALCULATION OF MAXIMUM TAILWATER

IN ORDER TO DETERMINE THE DEPTH OF TAILWATER, THAT FLOW WHICH IS DISCHARGED INTO THE DOWNSTREAM CHANNEL MUST BE ROUTED THROUGH ANY IMMEDIATE OBSTRUCTION. THE OBSTRUCTION IN QUESTION FOR BEAVER RUN DAM IS AN OVERPASS BRIDGE ALONG ROUTE 380 LOCATED APPROXIMATELY 190 FT DOWNSTREAM OF THE SPILLWAY OUTLET. (REF 6: DRWG 4

DIMENSIONS OF THE STRUCTURE WHICH PERTAIN TO THE CALCULATIONS TO FOLLOW ARE PRESENTED BELOW (TAKEN FROM FIELD NOTES)



PLAN

ASSUMPTIONS:

1. FLOW IS CONSIDERED TO BE OPEN CHANNEL THROUGH THE BRIDGE
2. DIMENSIONS OF ENTIRE DOWNSTREAM ARE CONSIDERED EQUAL TO LENGTH OF BRIDGE SPAN (75') AND HEIGHT OF BRIDGE DECK ABOVE STREAM BED (11')
3. SLOPE OF DOWNSTREAM CHANNEL IS ASSUMED TO APPROXIMATE 0.002 AS SCALED FROM U.S.G.S. 7.5 MIN MAP (VANDERGRIFT QUAD)

SUBJECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-8-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 6-8-78 SHEET NO. 21 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

APPLY MANNING'S EQUATION FOR OPEN-CHANNEL FLOW

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2} \quad \text{(REF 1, EQ 21-90)}$$

(SHEET 13) Q = QUANITY OF FLOW (MAXIMUM SPILLWAY DISCHARGE) = 3728 CFS

R = HYDRAULIC RADIUS (AREA OF FLOW / WETTED PERIMETER) = $(75ft)(x)/(2x+75ft)$

A = AREA OF FLOW = $(75ft)(x)$

S = SLOPE OF CHANNEL = 0.002

n = MANNING'S COEFFICIENT = 0.035

(REF 1; TABLE 21-11, PG 21-46 - AVG VALUE FOR UNLINED CHANNELS WITH ROCK BEDS THAT ARE SMOOTH AND UNIFORM)

$$3728 \text{ CFS} = \frac{1.486}{(0.035)} (75x) \left[\frac{(75x)}{(2x+75)}\right]^{2/3} (0.002)^{1/2}$$

$$3728 = 142.4x \left[\frac{(75x)}{(2x+75)}\right]^{2/3}$$

$$227,622 = 1699 x^{3/2} \left|\frac{(75x)}{(2x+75)}\right|$$

ECT DAM SAFETY INSPECTION
BEAVER RUN DAM

BY DLB DATE 6-8-78 PROJ. NO. 78-501-484

CHKD. BY JTS DATE 6-8-78 SHEET NO. 22 OF 22

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

$$455,244x + 17,071,650 = 127,425x^{5/2}$$

$$0 = x^{5/2} - 3.57x - 134$$

$$x < 11 \text{ FT}$$

$$7.0 < x < 8.0$$

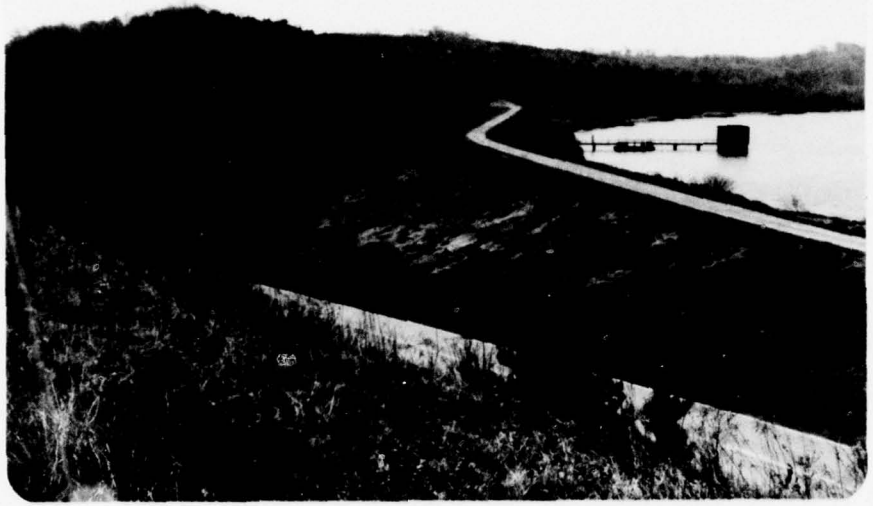
CONCLUSION: MAXIMUM DISCHARGE WILL OF THE SPILLWAY WILL CREATE A DEPTH OF TAILWATER NOT IN EXCESS OF 8 FEET. SINCE THE UNDERSIDE OF THE OVERPASS IS 11 FEET ABOVE THE STREAMBED IT CAN BE CONCLUDED THAT MAXIMUM DISCHARGE WILL BE ROUTED UNDERNEATH THE OBSTRUCTION.

APPENDIX D

PHOTOGRAPHS

PHOTOGRAPH 1 View looking across the top of the Beaver Run embankment. The spillway and gate house are shown on the right. The pump house is at the toe of the embankment in the left-central portion of the photograph.

PHOTOGRAPH 2 Panoramic view of the downstream slope of the Beaver Run Dam. The emergency spillway section (low spot in road at Route 380) can be seen in the right portion of the photograph.



1

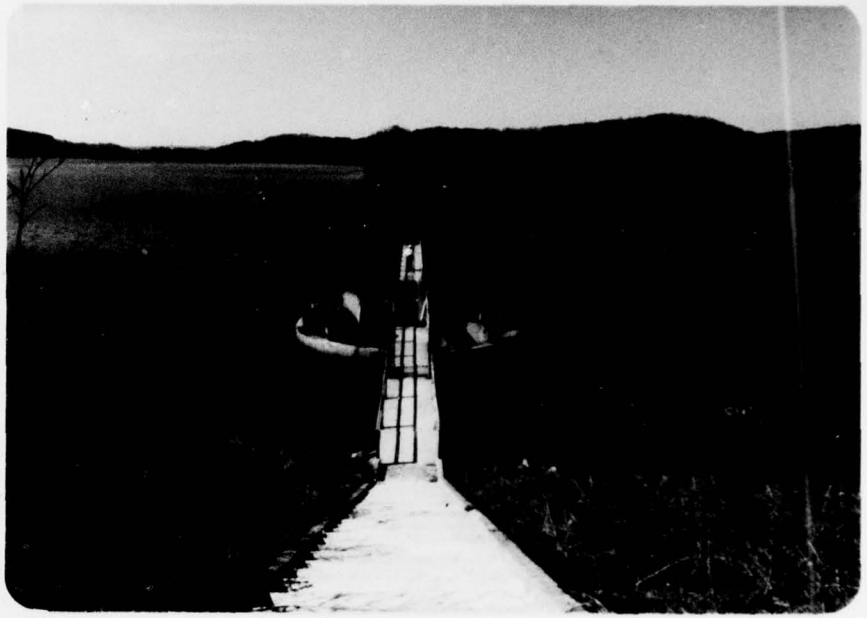
2

PHOTOGRAPH 3 View looking downstream from the crest of Beaver Run embankment showing a bridge on Route 380 which is located ≈400 feet downstream of the dam. Note the valley downstream of the dam.

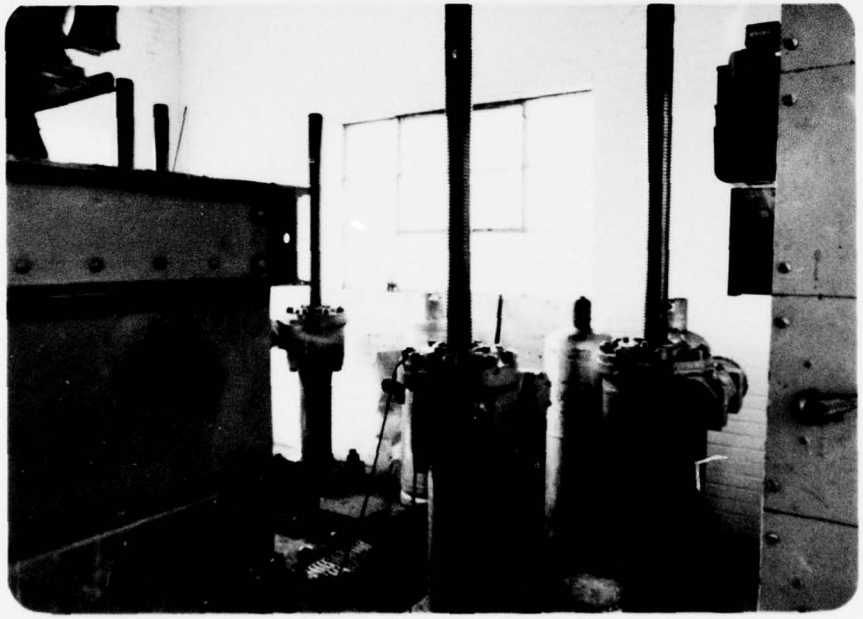
PHOTOGRAPH 4 View of the Morning Glory spillway which is the primary outlet works at the facility. The gate house is shown in the background.

PHOTOGRAPH 5 View of the three main valves in the gate house at the Beaver Run Facility. Numbers on each of the gate screws depict the elevation at which each of the particular gates can be opened to obtain water from different levels.

3



4



5

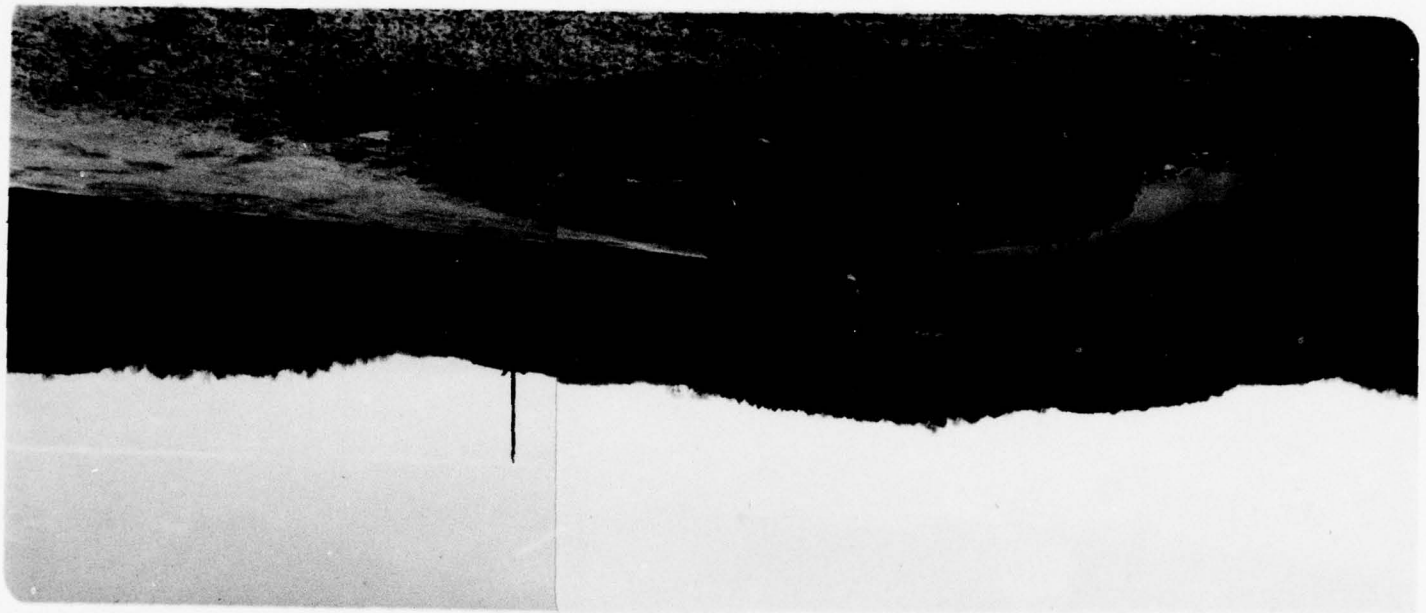
PHOTOGRAPH 6 View of seepage on the right abutment near elevation 1040.

PHOTOGRAPH 7 View of an erosion channel which has been cut at the intersection of the downstream slope of the dam and the right abutment. Flow in this area was gauged to be approximately 5 GPM.

6

7

PHOTOGRAPH 8 Panorama view of the downstream area from Beaver Run Reservoir. On the far left a few homes can be seen. The embankment is shown in the center of the panorama (see arrow).



APPENDIX E

GEOLOGY

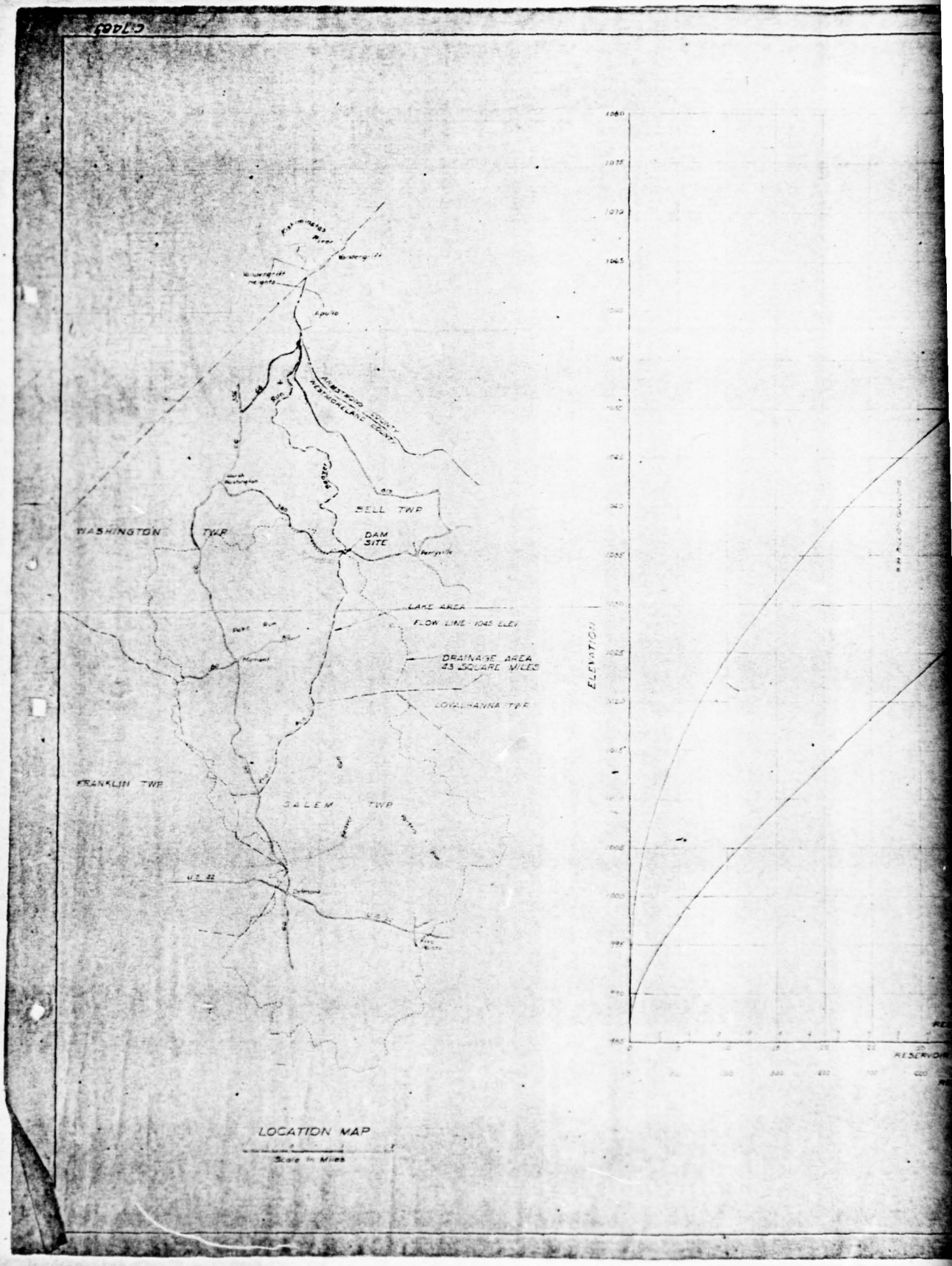
Beaver Run Dam is founded on sedimentary rocks of the Pennsylvanian age Conemaugh Formation. The formation can be characterized as a series of cyclic shales, siltstones and sandstones with smaller amounts of limestone and coal. The rocks in the reservoir area are nearly horizontal and are commonly well jointed. A log of the borings drilled during the subsurface investigation is provided on Drawing C-6487 (not provided in text).

APPENDIX F

FIGURES

APPENDIX F - FIGURES

Figure	Description/Title
1	Location Map and Capacity Curve
2	Plan of Dam
3	Miscellaneous Sections Through Dam
4	Cut-off Trench and Headwall at Tower
5	Drop Inlet and Circular Walkway Sections Intake Tower Details
6	Intake Tower Sections and Reinforcing Details


WASHINGTON TWP
BELL TWP
DAM SITE
LAKE AREA
FLOW LINE 1045 ELEV
DRAINAGE AREA
23 SQUARE MILES
LOYALHANNA TWP
FRANKLIN TWP
SALEM TWP
U.S. 22
LOCATION MAP
Scale in Miles
ELEVATION
RESERVOIR

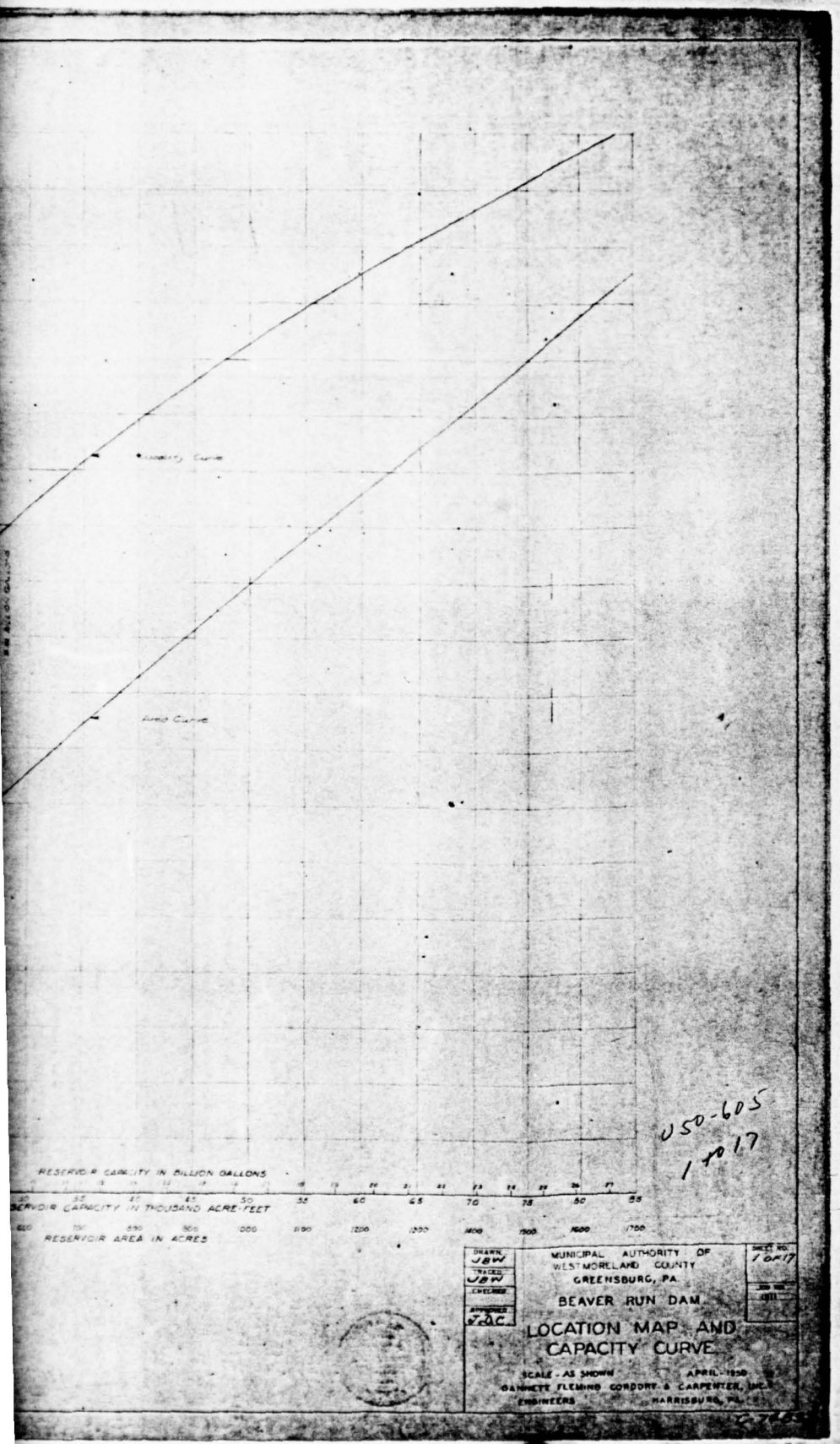
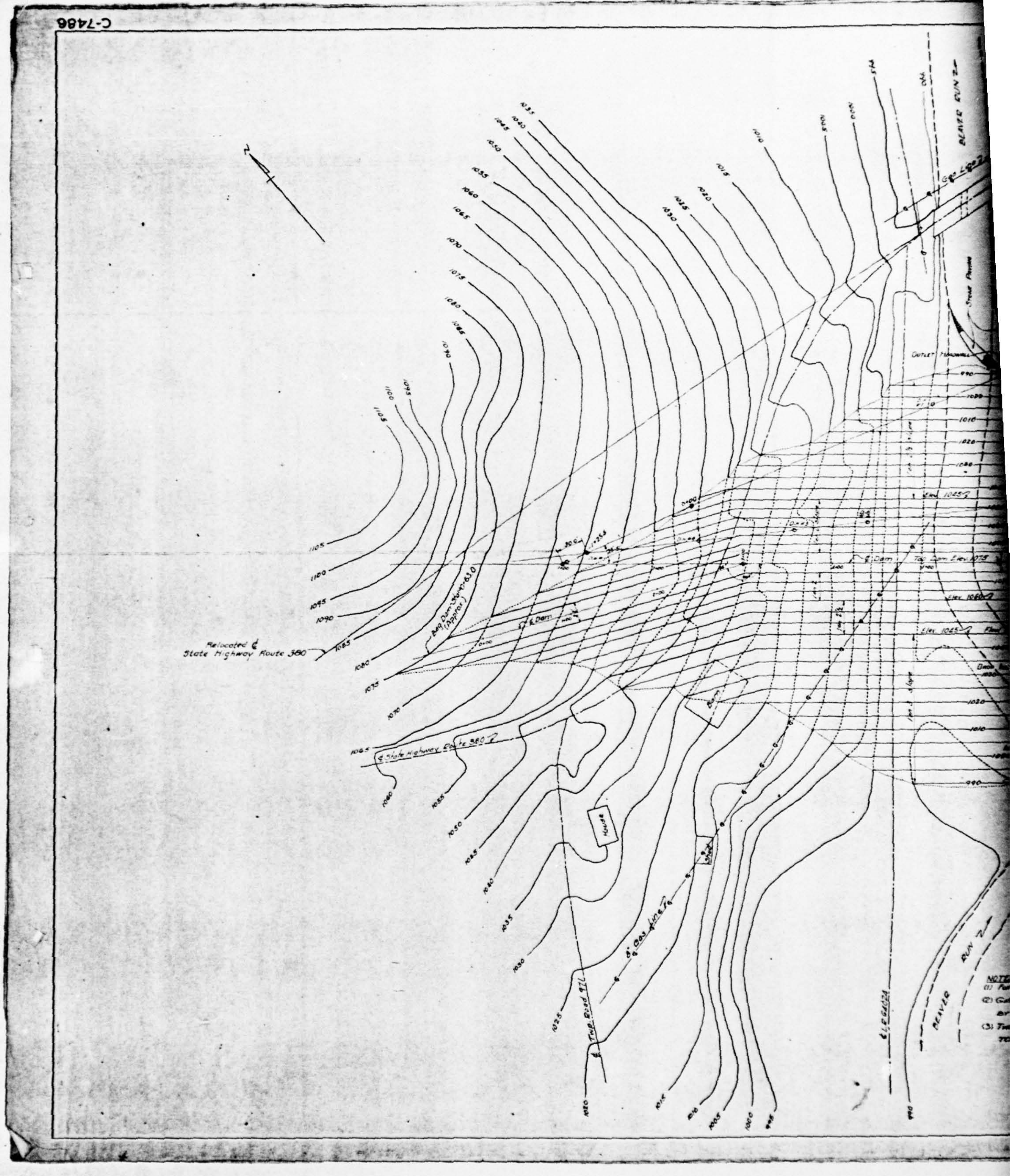

Capacity Curve
Area Curve
RESERVOIR CAPACITY IN BILLION GALLONS
RESERVOIR CAPACITY IN THOUSAND ACRE-FEET
RESERVOIR AREA IN ACRES
DRAWN JBW
TRACED JBW
CHECKED
APPROVED J.A.C.
MUNICIPAL AUTHORITY OF
WESTMORELAND COUNTY
GREENSBURG, PA.
BEAVER RUN DAM
LOCATION MAP AND
CAPACITY CURVE
SCALE - AS SHOWN
APRIL - 1950
GANNETT FLEMING CORDDRY & CARPENTER, INC.
ENGINEERS
HARRISBURG, PA.
SHEET NO. 1 OF 17
USO-605
1 of 17

FIGURE 1


C-7488
N
BEAVER RUN
Relocated ℄ State Highway Route 380
℄ State Highway Route 380
Outlet
Top Dam Elev 1075
Elev 1060
Elev 1045
℄ Dam
House
Twp. Road
Gas Line
BEAVER RUN
NOTES
1105
1100
1095
1090
1085
1080
1075
1070
1065
1060
1055
1050
1045
1040
1035
1030
1025
1020
1015
1010
1005
1000
995
990

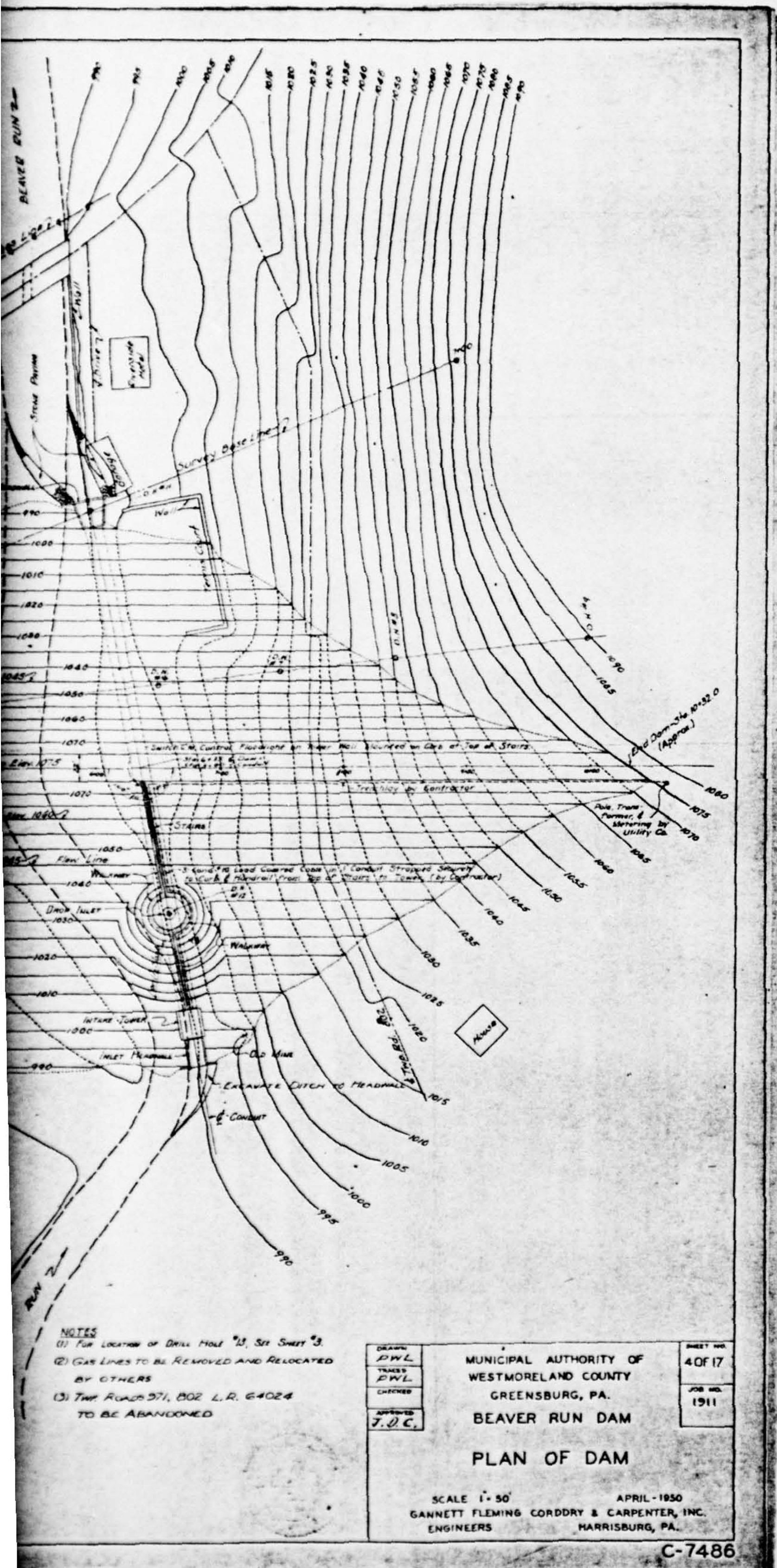
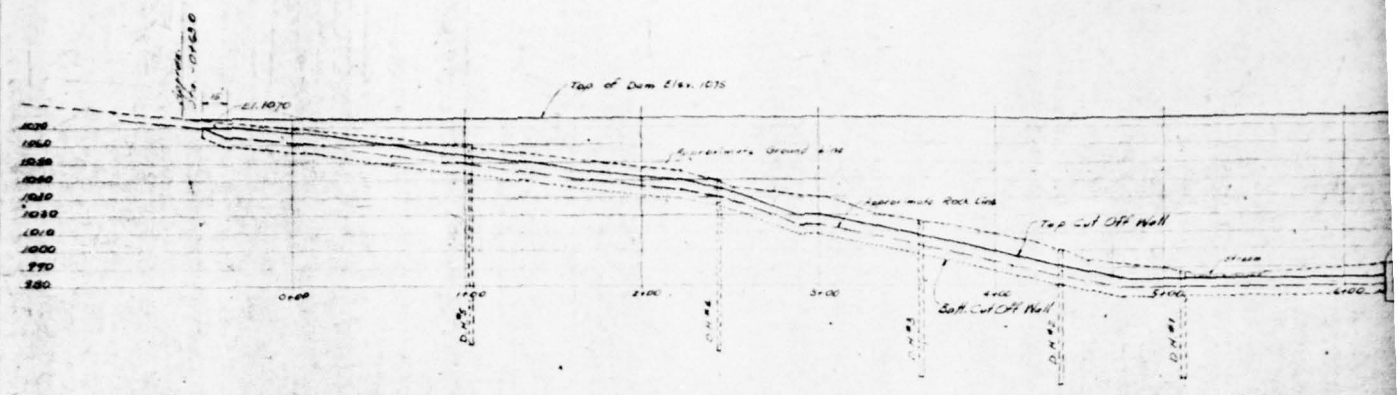
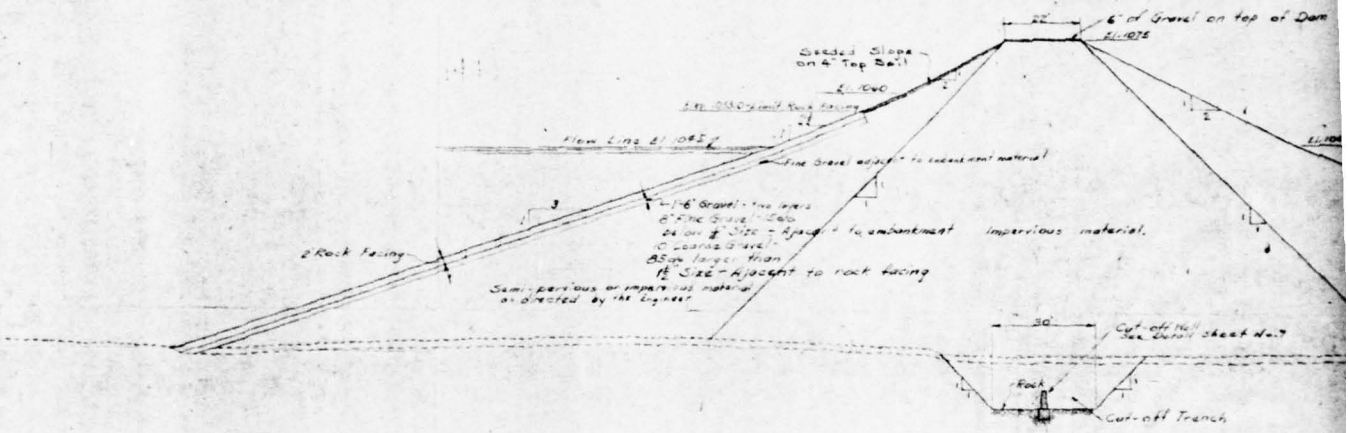

BEAVER RUN
Survey Base Line
Stairs
Walkway
Drop Inlet
Intake Tower
Inlet Headwall
Old Mine
Excavate Ditch to Headwall
Conduit
House
RUN
NOTES
(1) For Location of Drill Hole #13, See Sheet #3.
(2) Gas Lines to be Removed and Relocated by Others
(3) Twp. Roads 971, 802 L.R. 64024 to be Abandoned
DRAWN PWL
TRACED PWL
CHECKED
APPROVED J.D.C.
MUNICIPAL AUTHORITY OF WESTMORELAND COUNTY
GREENSBURG, PA.
BEAVER RUN DAM
PLAN OF DAM
SCALE 1" = 50'
APRIL - 1950
GANNETT FLEMING CORDDRY & CARPENTER, INC.
ENGINEERS
HARRISBURG, PA.
SHEET NO. 4 OF 17
JOB NO. 1911
C-7486

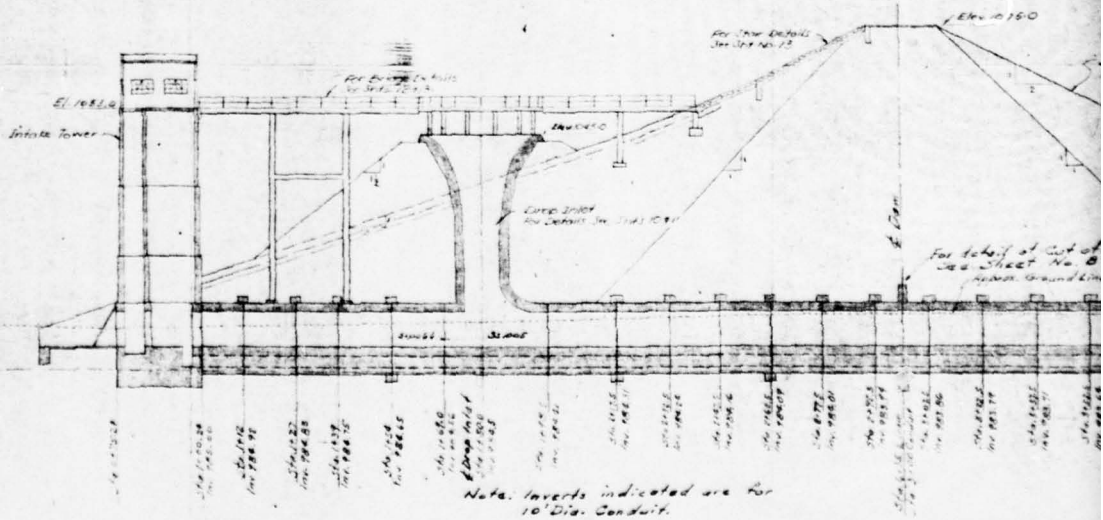
FIGURE 2



LONGITUDINAL SECTION ALONG CENTER
Scale 1"=40'



TYPICAL CROSS SECTION THROUGH DAM
Scale 1"=30'



CROSS SECTION THROUGH DAM - DROP IN
Scale 1"=20'

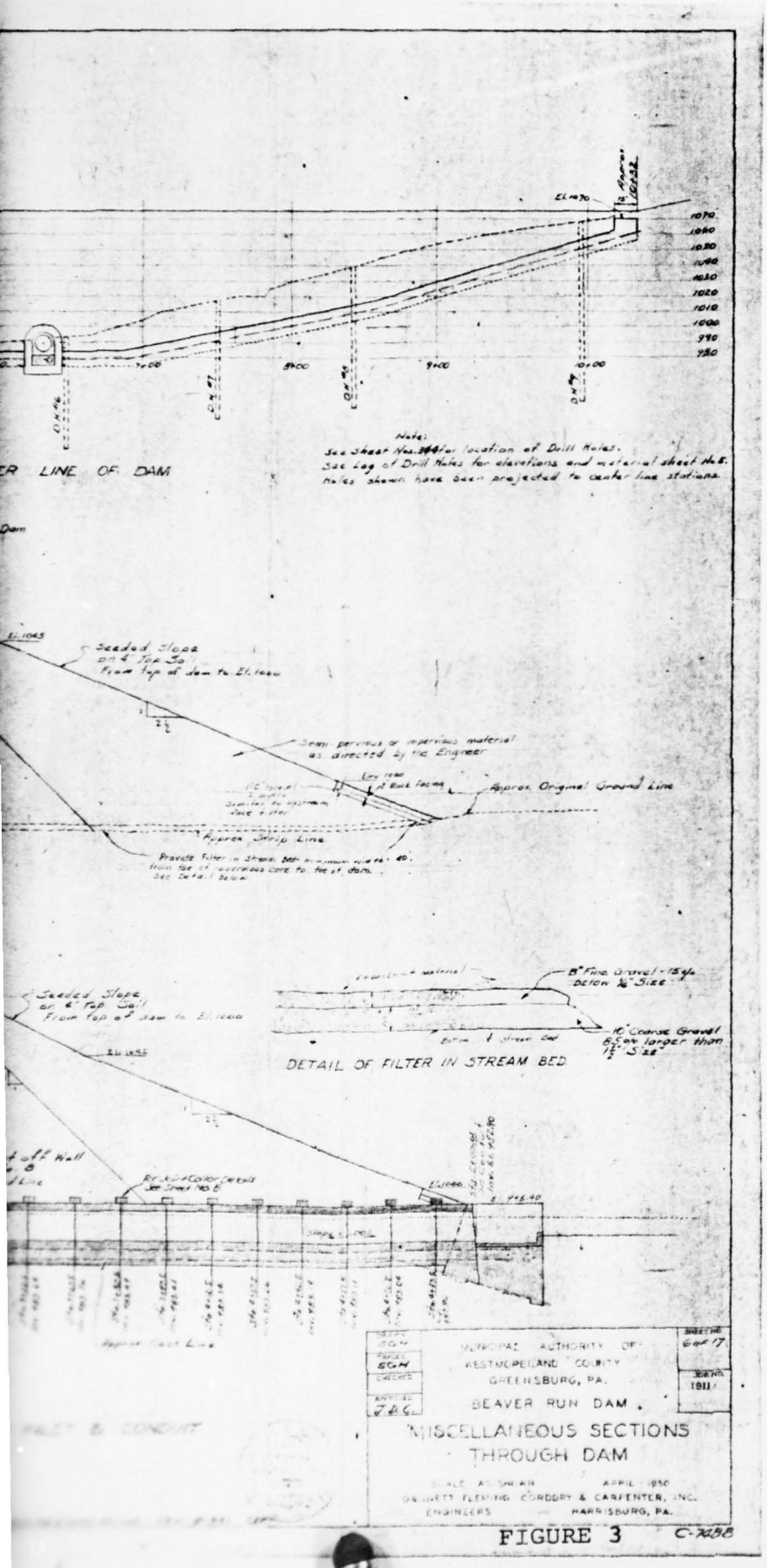
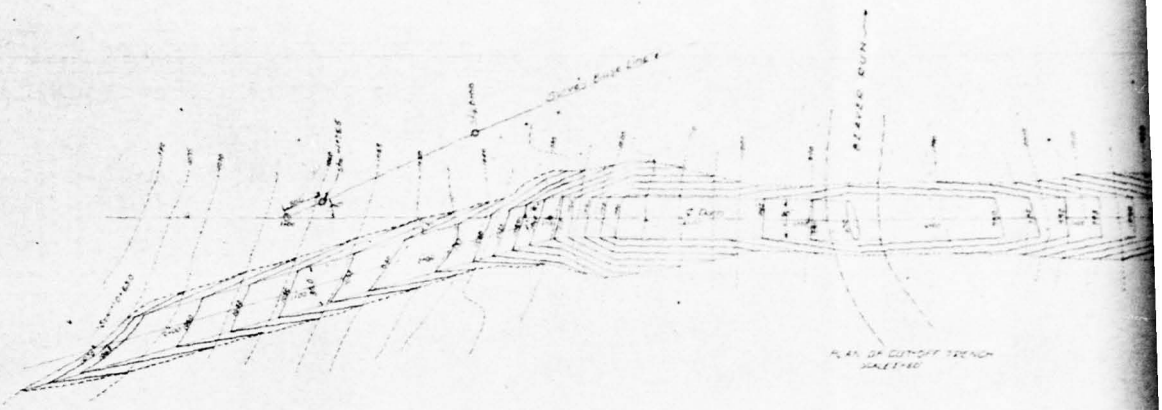
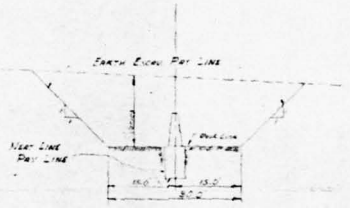


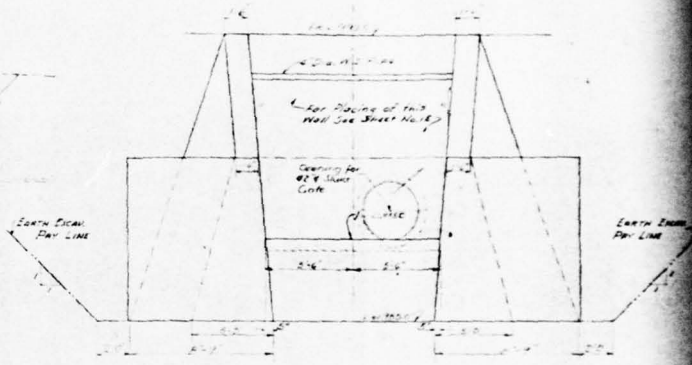
FIGURE 3 C-7098

68DL-D

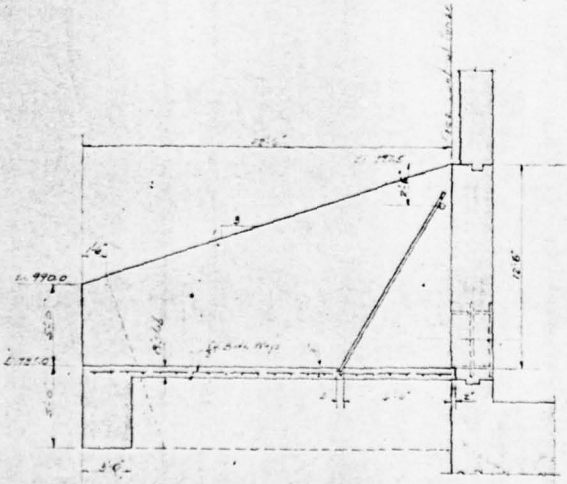


PLAN OF CUTOFF TRENCH
SCALE 1"=50'



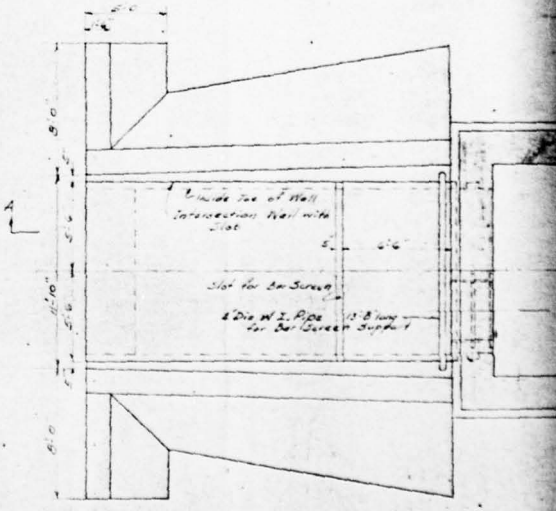


FRONT ELEVATION OF WALLS AT INTAKE TOWER
SCALE 1/16"=1'-0"



ELEVATION A-A
SCALE 1/16"=1'-0"

NOTES:
(1) FOR TOWER PAINT DETAILS, SEE SHEET No. 14
(2) FOR CLOSURE OF OPENINGS, SEE SHEET No. 15.



PLAN OF WALLS AT INTAKE TOWER
SCALE 1/16"=1'-0"

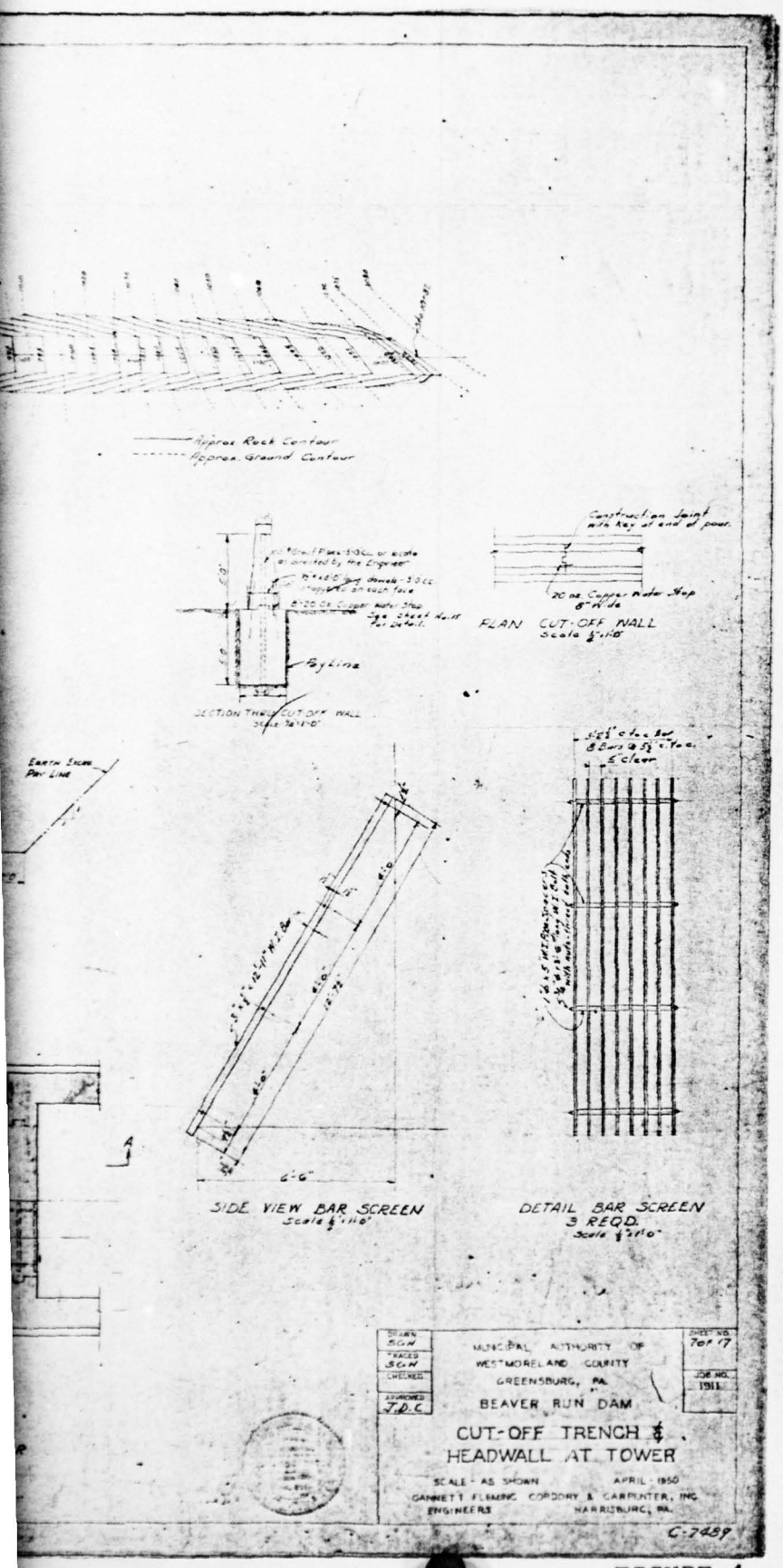
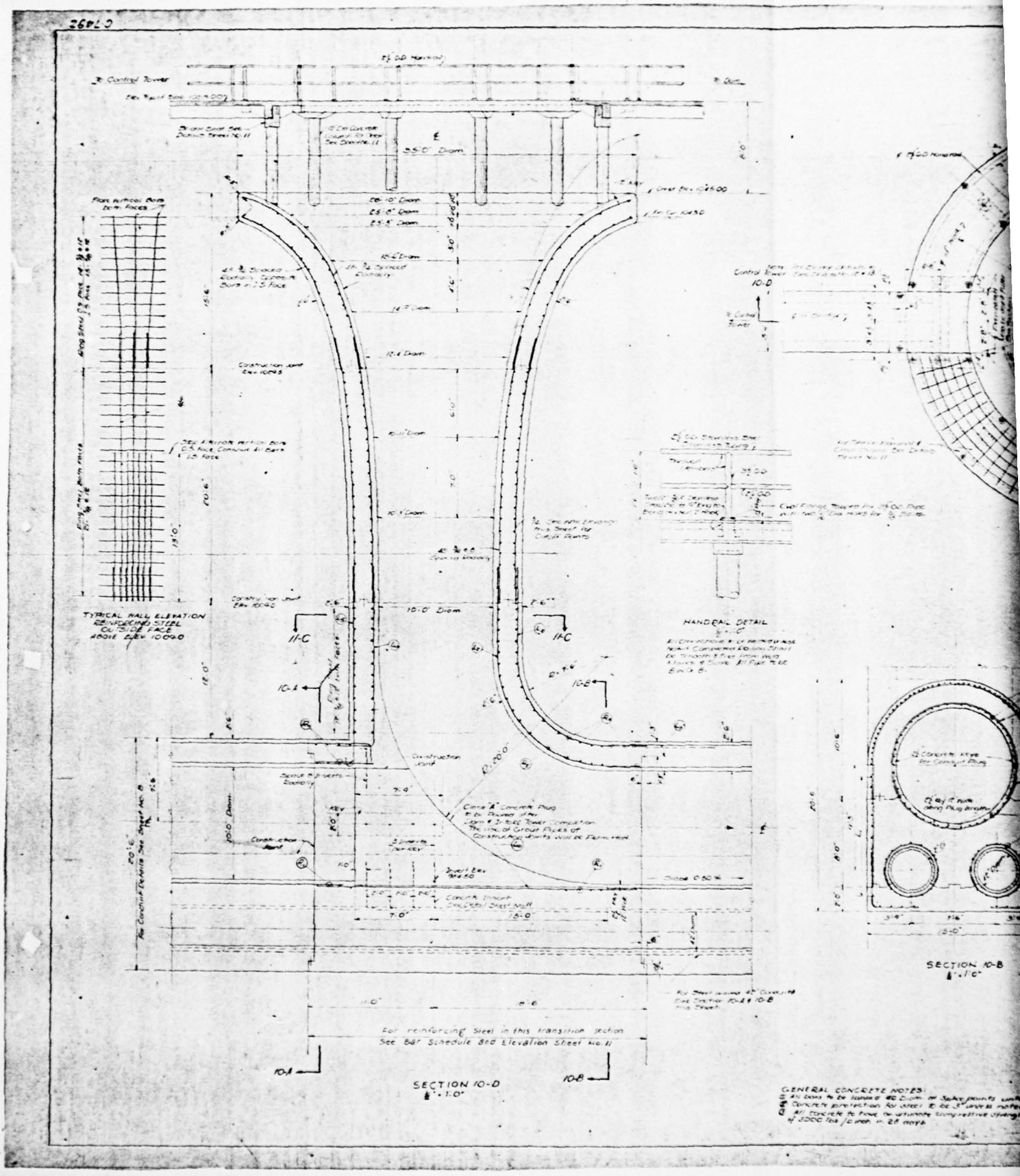

Approx Rock Contour
Approx. Ground Contour
Construction Joint with Key at end of pour.
20 oz. Copper Water Stop 6" Wide
PLAN CUT-OFF WALL
Scale 1/16"
Bytine
SECTION THRU CUT-OFF WALL
Scale 1/16"
EARTH SLOPE PER LINE
SIDE VIEW BAR SCREEN
Scale 1/16"
DETAIL BAR SCREEN
3 REQD.
Scale 1/2"=1'0"
2'-6"
MUNICIPAL AUTHORITY OF WESTMORELAND COUNTY
GREENSBURG, PA.
BEAVER RUN DAM
CUT-OFF TRENCH & HEADWALL AT TOWER
SCALE - AS SHOWN
APRIL - 1950
GANNETT FLEMING CORDDRY & CARPENTER, INC.
ENGINEERS
HARRISBURG, PA.
C-7459
SHEET NO. 7 OF 17
JOB NO. 1911
DRAWN SGW
TRACED SGW
CHECKED
APPROVED J.D.C

FIGURE 4


TYPICAL WALL ELEVATION
REINFORCING STEEL
ON OUTSIDE FACE
ABOVE ELEV. 10040
HANDRAIL DETAIL
SECTION 10-D
SECTION 10-B
For reinforcing Steel in this transition section
See Bar Schedule and Elevation Sheet No. 11
GENERAL CONCRETE NOTES:

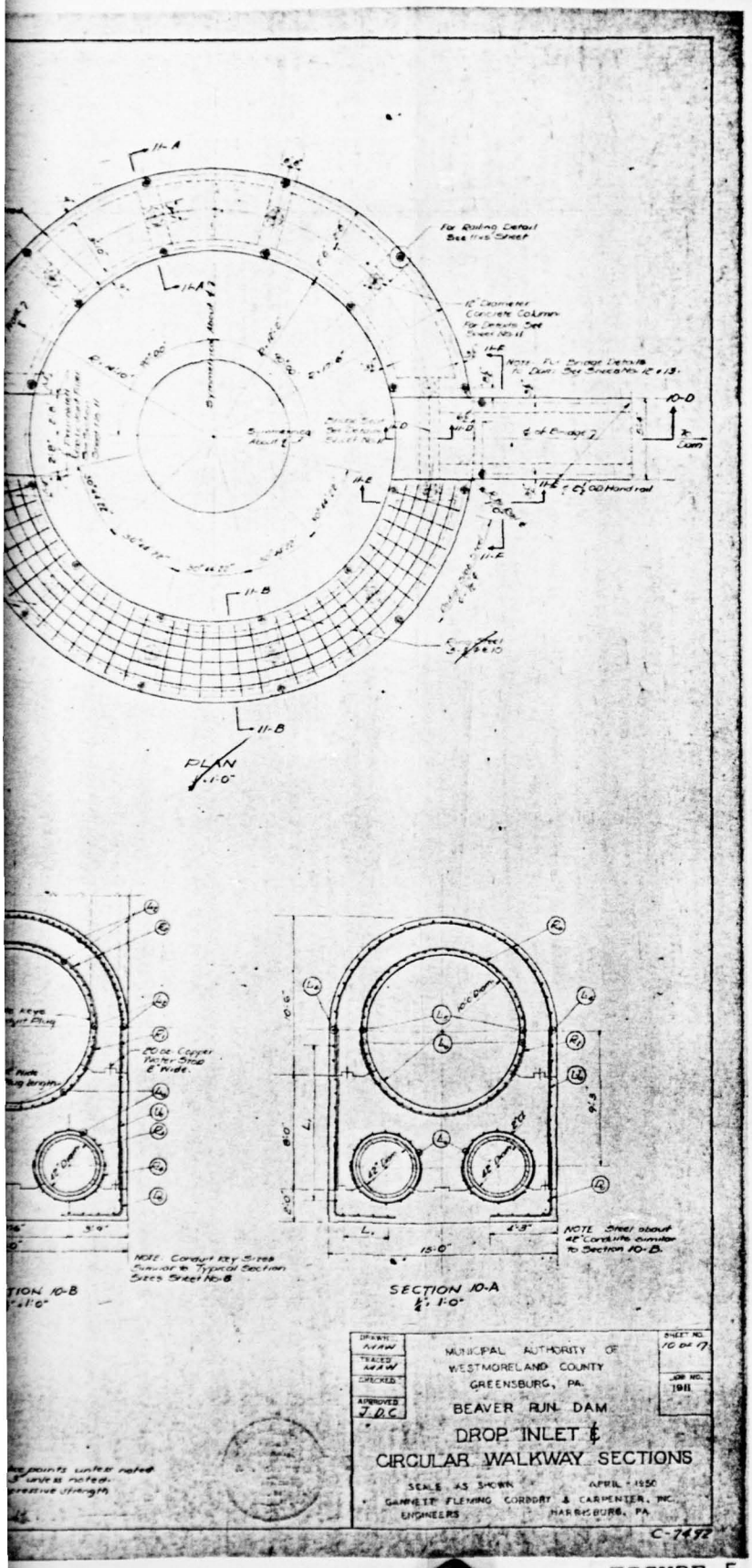
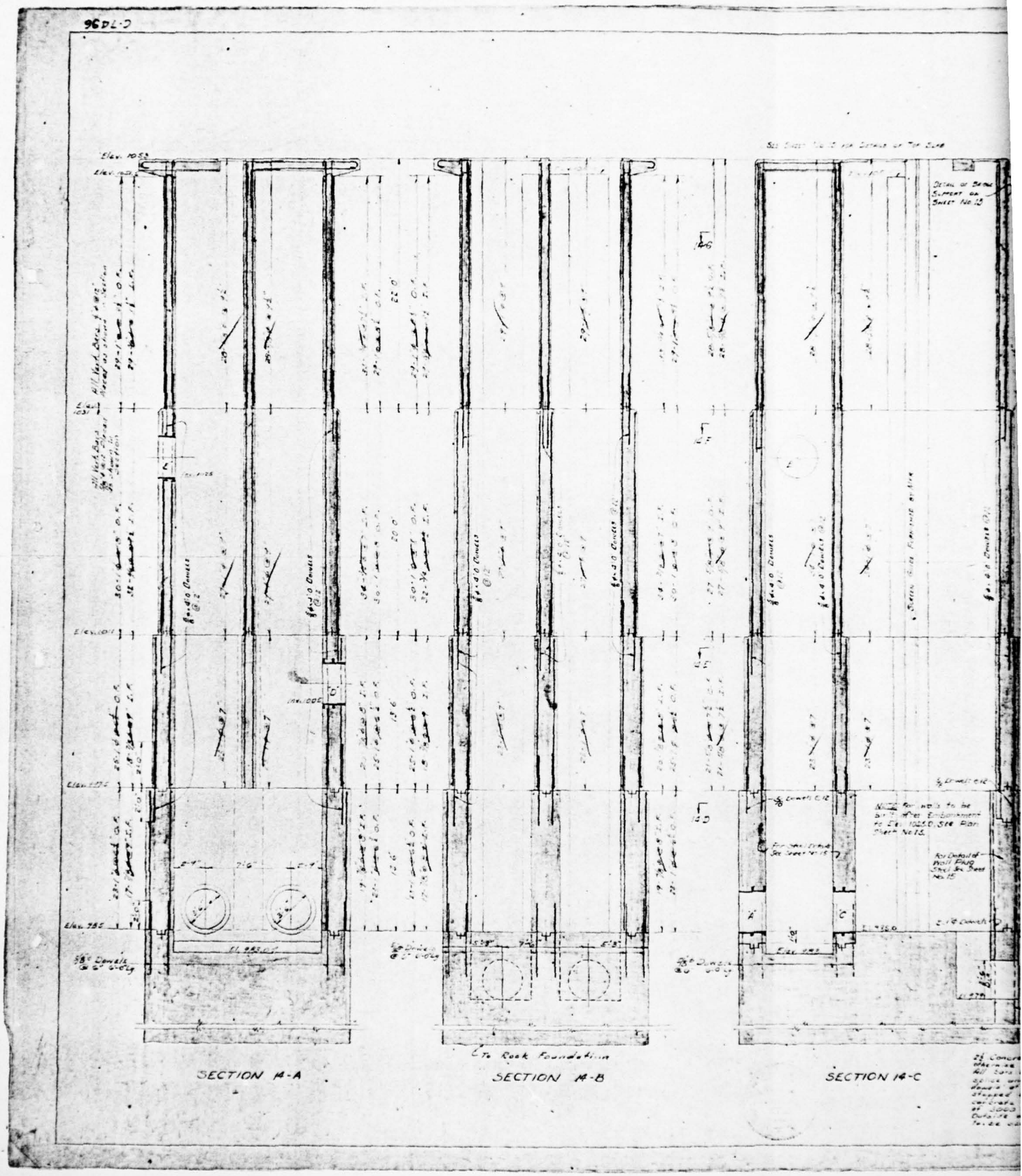

PLAN
1"=10'
SECTION 10-A
1/2"=1'-0"
SECTION 10-B
MUNICIPAL AUTHORITY OF
WESTMORELAND COUNTY
GREENSBURG, PA.
BEAVER RUN DAM
DROP INLET & CIRCULAR WALKWAY SECTIONS
SCALE AS SHOWN
APRIL 1950
GANNETT FLEMING CORDDRY & CARPENTER, INC.
ENGINEERS
HARRISBURG, PA.
C-7492

FIGURE 5


SECTION 14-A
SECTION 14-B
SECTION 14-C

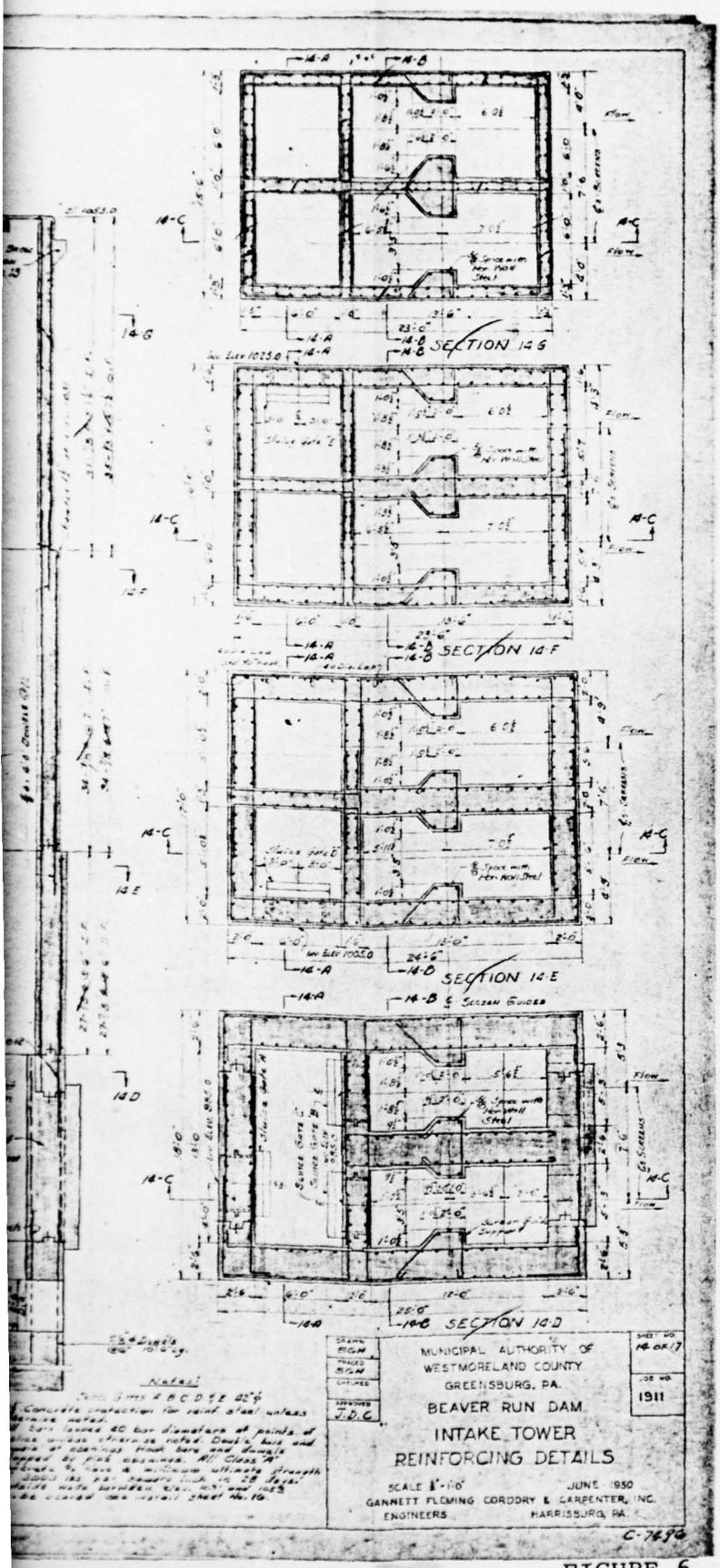
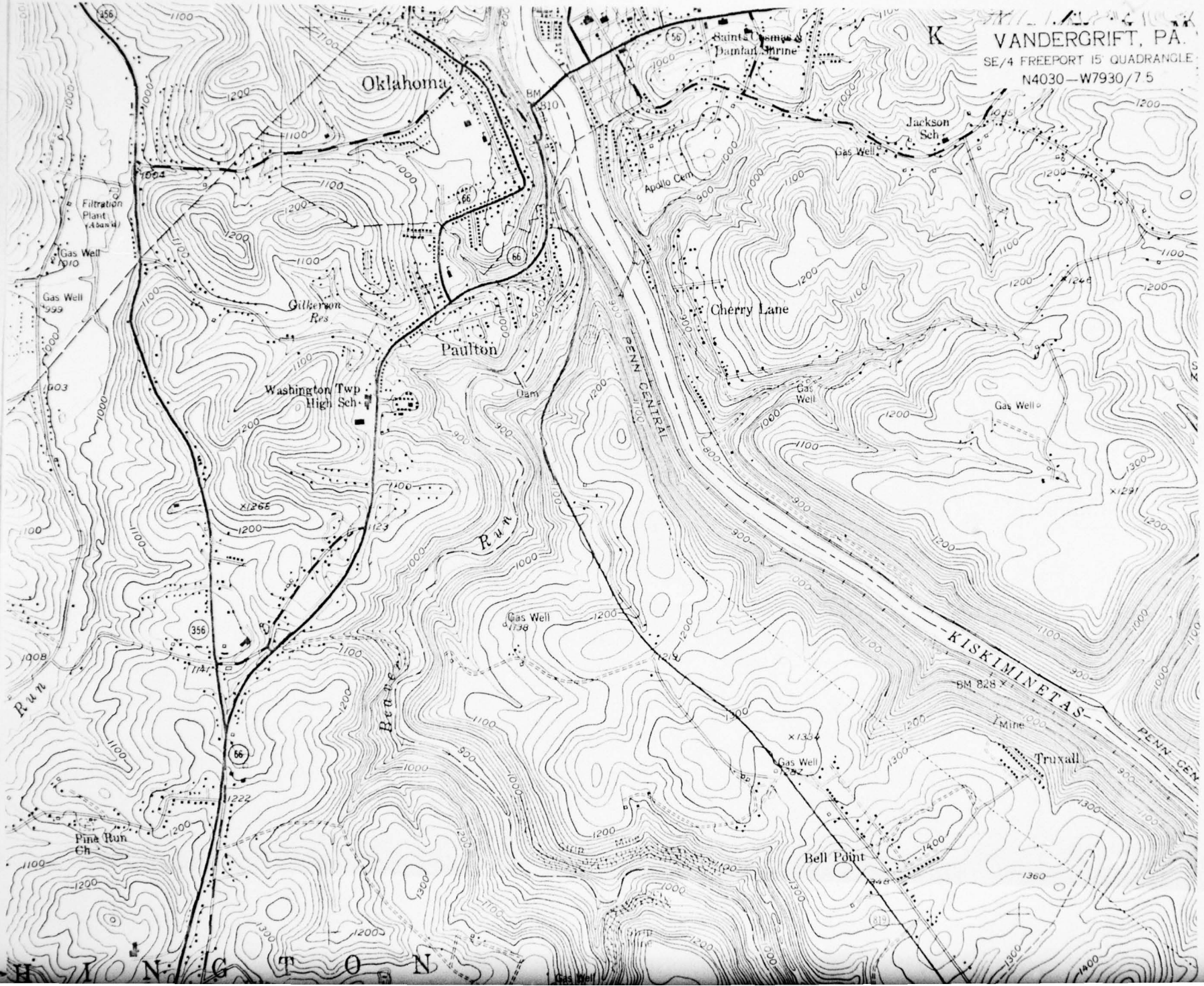
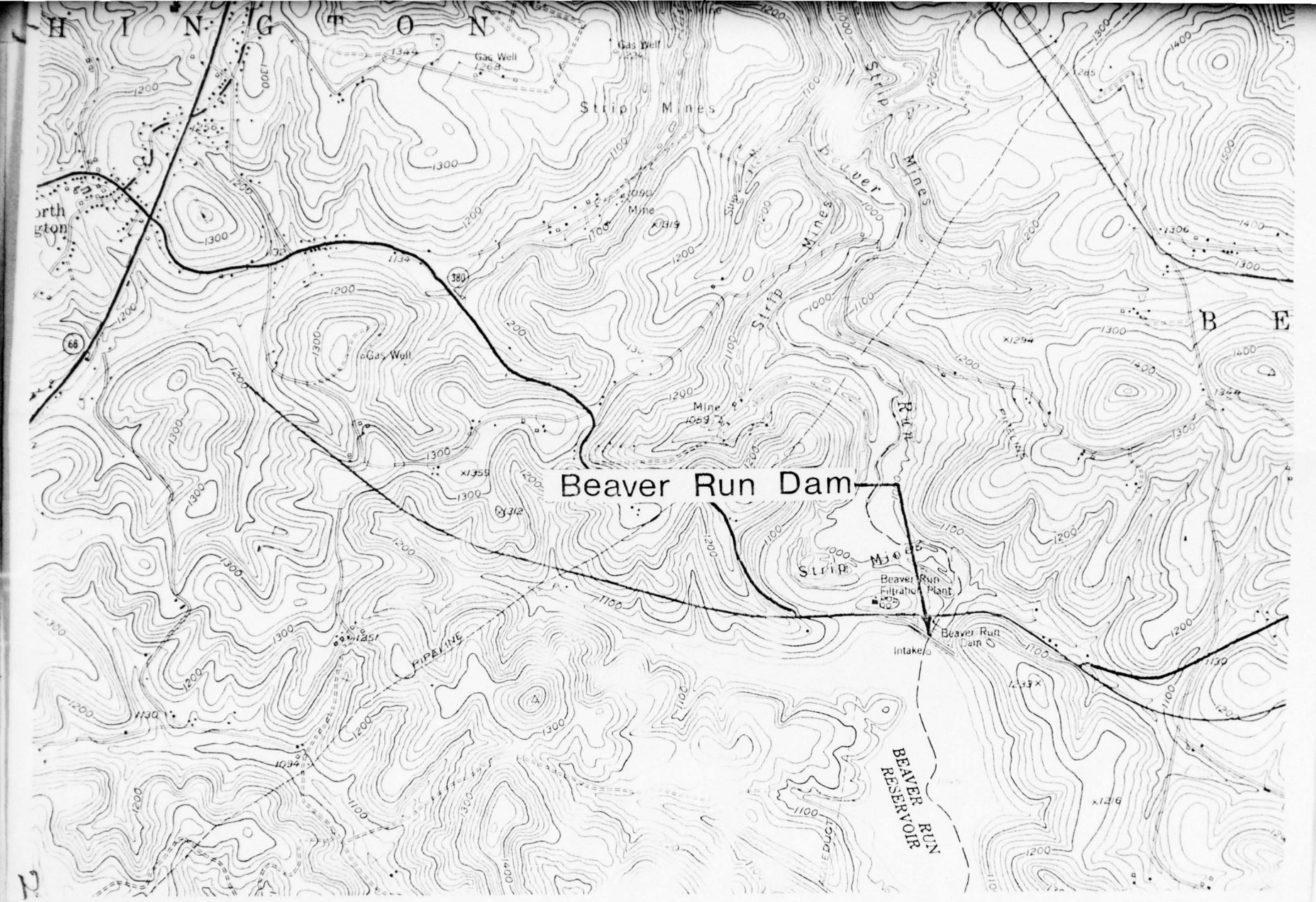

SECTION 14-G
SECTION 14-F
SECTION 14-E
SECTION 14-D
MUNICIPAL AUTHORITY OF
WESTMORELAND COUNTY
GREENSBURG, PA.
BEAVER RUN DAM
INTAKE TOWER
REINFORCING DETAILS
SCALE 1"-1'0"
JUNE 1950
GANNETT FLEMING CORDDRY & CARPENTER, INC.
ENGINEERS
HARRISBURG, PA.
1911
C-7696

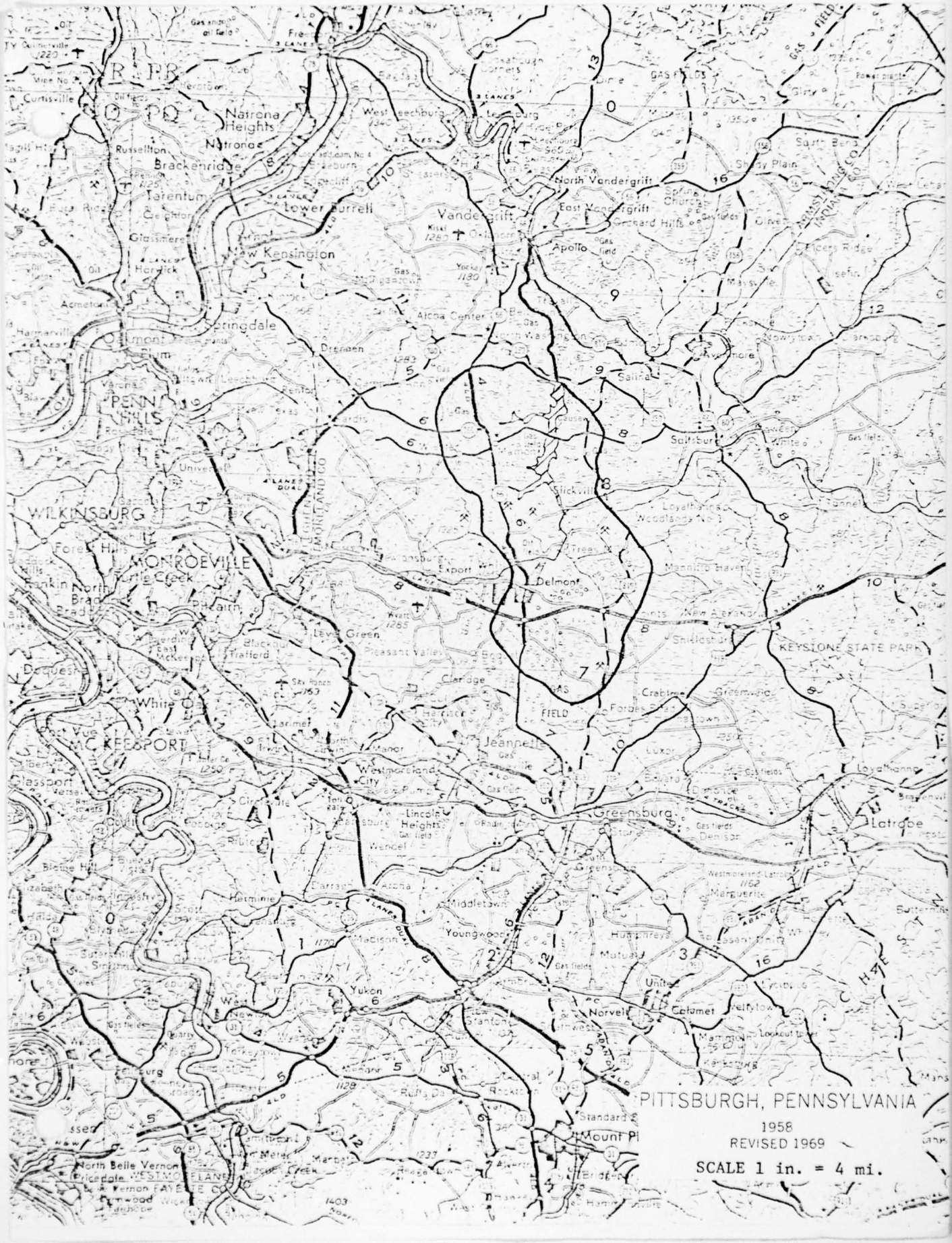
FIGURE 6

APPENDIX G

REGIONAL VICINITY MAP


K
VANDERGRIFT, PA.
SE/4 FREEPORT 15' QUADRANGLE
N4030—W7930/7.5
Oklahoma
Saints Cosmas & Damian Shrine
Jackson Sch
Gas Well
Apollo Cem
Filtration Plant (Abandd)
Gas Well 1010
Gas Well 999
Gilkerson Res
Paulton
Cherry Lane
PENN CENTRAL
Washington Twp High Sch
Dam
Gas Well
Gas Well
Run
Gas Well 1138
KISKIMINETAS
BM 828
Mine
Truxall
Gas Well 857
Bell Point
Pine Run Ch
Beaver
Run
H I N C T O N
Gas Well


Beaver Run Dam
Strip Mines
Gas Well
Mine
Beaver Run Filtration Plant
Beaver Run Dam
Intake
BEAVER RUN RESERVOIR
PIPELINE
Beaver Run
380
68


PITTSBURGH, PENNSYLVANIA
1958
REVISED 1969
SCALE 1 in. = 4 mi.